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AN AUSTRALIAN ACADEMY OF SCIENCE

IN 1951 the Australian National University organized a seminar on "Science in Australia" as part of the jubilee celebrations of the Federation of the Australian States. This gathering, generally representative of Australian science, was aided greatly in its discussions by the presence of Sir Edward Mellanby, from Great Britain, and of Dr. J. B. Conant, president of Harvard University. Scientific activity in Australia was reviewed in an endeavour to find how best it should develop in the future. It had become clear that in a country of such large size, with a scattered scientific community, where responsibility for scientific work is divided between the universities and institutions of the various States, on one hand, and those of the Commonwealth Government on the other, it is extremely difficult to preserve unity and to ensure that achievement is recognized and fostered. The relative isolation of Australian scientists, not only from scientists abroad, but also from their colleagues within Australia, is a major hardship. Much has been achieved and science has made a great contribution to the welfare of Australia; but it is felt that the development of an integrated scientific community will stimulate greater progress. For these reasons the proposal by Prof. M. L. Oliphant that active steps be taken to found an Australian Academy of Sciences received strong support.

The idea of a national scientific body in Australia is not new. Several attempts have been made in the past to establish an institution to encourage the pursuit of natural knowledge as do the Royal Society in Great Britain and the various national academies of science in Europe and America. These attempts were frustrated by the time and expense involved in bringing even a small number of men of science together for regular meetings in the days before air travel virtually eliminated time consumed in movement about Australia, or a rapidly growing public appreciation of science, and the part played by science in the development of the country, made it easier to obtain financial support for scientific activities. Inter State jealousies, and the fear by the States of encroachment by the Commonwealth upon their rights and privileges, added to the difficulties encountered.

The only effective scientific body which covered the continent was the Australian and New Zealand Association for the Advancement of Science (A.N.Z.A.A.S.), closely resembling the British Association in the United Kingdom. The periodic meetings of the Association became the natural means of personal contact between scientists. The sectional sessions became serious scientific discussions, and the habit grew of holding meetings and congresses of scientific societies during the gatherings of A.N.Z.A.A.S. It was natural, therefore, that the endeavour after the First World War to form international scientific bodies should result in the formation of a National Research Council (A.N.R.C.), at first as an independent body, but

later composed of the Australian Fellows of A.N.Z.A.A.S.

Within the limitations imposed by lack of funds and its diffuse membership, A.N.R.C. has done a great deal for Australian science. In particular, it has fostered national and international congresses, encouraged the pursuit of anthropology, urged the development within the universities and government institutions of necessary scientific activities, and has given advice to State and Commonwealth governments upon matters affecting research and teaching in science. Its members have been informed of its activities through the publication of the *Australian Journal of Science*; it has established and maintained responsibility for the anthropological journal *Oceania*, and more recently has collaborated with the Commonwealth Scientific and Industrial Research Organization in the general supervision of the *Australian Journal of Scientific Research*. However, because of its very restricted resources, the A.N.R.C. has been entirely dependent upon a few devoted officers in Sydney and Melbourne, between which cities the Executive Council has alternated every few years; members of this Council from other States have been unable to attend its meetings and have had to nominate proxies, while lack of contact between the ordinary members has led to growing apathy on the part of the majority.

For these and other reasons, including the relationship with A.N.Z.A.A.S., it became the general feeling of members that there was little prospect of reforming A.N.R.C. from within so that it could discharge effectively the functions of a national body representative of science in Australia.

Dr. D. F. Martyn and Prof. M. L. Oliphant decided to make a fresh approach to the problem by inviting the Fellows of the Royal Society resident in Australia to become the foundation members of a new organization. This group of thirteen chose eleven other Australian scientists, who it was unanimously agreed should be potential members of an Academy, to sit with them as founders of the new body. The A.N.R.C. was kept fully informed at all stages of the discussions, and joint meetings with its Executive Committee were held in Sydney and in Canberra. At the annual meeting of A.N.R.C. on August 19, unanimous approval was given to the proposals for an Academy, and it was decided that when in active operation it will take over the present functions and responsibilities of A.N.R.C. It is a tribute to the spirit of Australian science that, in the common cause, some 150 scientists should, by this action, have withdrawn voluntarily from immediate participation in the government of the principal scientific society in the country.

At an early stage in the discussions representatives of the embryonic Academy were received by the Prime Minister, who expressed keen interest in the proposed institution and said that his Government would give sympathetic consideration and support to a national body which was adequately representative of Australian science and which had ensured that it would maintain high standards.

The task before the foundation group of the Academy is now to draw up a constitution, statutes and rules and to apply for a Royal Charter. The Commonwealth Solicitor-General and his Office have agreed to give guidance upon procedures.

Since the pursuit of science is now a major activity in a developing Australia, it is probable that the Fellows of the Academy will number eighty in the course of time. This would be approximately the same proportion, on a population basis, as the Fellowship of the Royal Society in Great Britain. However, it is not anticipated that the number of Fellows in the early years will rise rapidly above about fifty.

In order that the wide representation of scientific men provided by A.N.R.C. should not be destroyed, and to foster regional interest in the Academy, it is contemplated that a number of regional committees will be established consisting of Fellows of the Academy resident in a region together with a number of local scientists who are not Fellows. These regional committees will have no part in the government of the Academy, but will advise the parent body upon the scientific problems and needs of the widely dispersed parts of the continent.

The headquarters of the Academy will be in the Federal Capital, Canberra, where it is hoped that suitable accommodation will be provided. The government of the Academy will be modelled upon that of the Royal Society, with modifications to suit Australian conditions.

The foundation group of the new body consists of the following Fellows of the Royal Society: Sir Douglas Mawson, Antarctic explorer and professor of geology in the University of Adelaide; Sir David Rivett, formerly chairman and chief executive officer of C.S.I.R.O. and formerly professor of chemistry in the University of Melbourne; Sir Macfarlane Burnet, director of the Walter and Eliza Hall Institute of Medical Research in Melbourne; Prof. J. C. Eccles, professor of physiology in the John Curtin School of Medical Research, Australian National University; Prof. O. Tiegs, professor of zoology in the University of Melbourne; H. R. Marston, chief of the Division of Nutrition and General Biochemistry, C.S.I.R.O., Adelaide; Prof. T. G. Room, professor of mathematics (pure), University of Sydney; Dr. D. F. Martyn, chief scientist of the Radio Research Board, Canberra; Prof. J. A. Prescott, director of the Waite Agricultural Institute, Adelaide, and professor of agricultural chemistry in the University of Adelaide; Prof. K. E. Bullen, professor of mathematics (applied), University of Sydney; Prof. D. G. Catcheside, professor of genetics in the University of Adelaide (Waite Institute); Dr. R. Lemberg, Institute of Medical Research, Royal North Shore Hospital, Sydney; and Prof. M. L. Oliphant, director of the Research School of Physical Sciences, Australian National University; together with the following: Prof. R. v. d. R. Woolley, Commonwealth astronomer and professor of astronomy in the Australian National University, Commonwealth Observatory, Canberra; J. Pawsey, assistant chief of the Division of Radiophysics, C.S.I.R.O., Sydney; Prof. R. J. W. LeFevre, professor of chemistry, University of Sydney; Prof. S. Sunderland, professor of anatomy in the University

of Melbourne; I. Clunies-Ross, chairman of C.S.I.R.O., Melbourne; Prof. T. M. Cherry, professor of mathematics, University of Melbourne; Prof. L. G. Huxley, professor of physics in the University of Adelaide; Prof. E. S. Hills, professor of geology in the University of Melbourne; A. J. Nicholson, chief of the Division of Entomology, C.S.I.R.O., Canberra; Prof. L. H. Martin, professor of physics in the University of Melbourne; with Prof. H. K. Ward, chairman of A.N.R.C., as an observer. Dr. D. F. Martyn is acting as secretary *pro tem.*

THE AMERICAN FARMER AND HIS WOODLANDS

Forestry in Farm Management

By R. H. Westveld and the late Ralph H. Peck. Second edition, revised by R. H. Westveld. Pp. xi+340. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 40*s.* net.

ALTHOUGH I have not had the good fortune to visit the United States and its forest areas, I feel that an intimate knowledge of American forestry practice is not necessary in order to recognize the merits of this admirable book. If there was a British version (and how valuable it would be), it could well be renamed "Forestry in *Estate* Management", since this book would appear to have more in common with estate forestry in Great Britain than with farm woodlands as we know them over here.

Judging from the advice offered to American readers, it would seem that there are many aspects of private woodland management which are common to both countries. The effect of the Second World War, the need for efficient utilization, the absorption of certain types of woodland produce (such as fencing material) by the grower on his own property, the Christmas tree market, and the need for proper records and accounting, are only a few examples.

The first chapter deals with the relationship between agriculture and forestry, the contribution which forestry can make to food production, and the reason why forestry fails to do so in some cases. The figures quoted are, of course, in respect of the United States. The next two chapters are concerned with what may be described as the elements of forestry, the choice of species, site requirements, how a tree grows, even-aged and uneven-aged woods, and density and methods of propagation, being some of the points which are considered.

The problem of damage by natural and artificial causes, and the steps to be taken in combating them, are covered by parts of the third and fourth chapters. The greater portion of the fourth chapter deals, however, with forest management. Under this heading, particular attention is directed to the need for improving immature and partially stocked areas; both these matters are often the concern of foresters in Great Britain to-day. Thinning and pruning are also considered in this chapter. It is interesting to observe that, although natural regeneration and 'selection cutting', 'group-selection cutting' and 'shelterwood cutting' are dealt with, no reference is made to sylvicultural systems as such. Doubtless the authors thought that it was unnecessary for their readers to delve too deeply into these matters.

Chapter 5 is devoted to planting and refers, *inter alia*, to planting compared to direct seeding, to pure and mixed stands, to the choice of young stock and to spacing. On the subject of methods of planting it is interesting to see that the method known in Britain as 'pit-planting' is referred to as 'hole-planting', and 'notch-planting' as 'slit-planting'. The remarks on planting machines are particularly interesting, since this equipment has not yet appeared in Britain to any general extent. The type described has a planting capacity of approximately ten thousand trees per eight-hour day with a crew of two. If a man plants by hand 500–700 trees per day under 'average' conditions, a planting machine will show an eight- or nine-fold increase, which is a very substantial amount. The cost of the machines varies from 200 to 750 dollars (approximately £70–250). As regards planting costs, a formula for ascertaining these is given, and it is added that costs vary from 6 to 30 dollars per acre (£2–10) including the trees. Even allowing for wide spacing, cheap trees, and without rabbit netting, such as we have to erect in Britain, these figures seem very low. Without netting, costs in Britain are seldom less than £25 per acre, and with netting may well be £40 per acre for small areas.

The following four chapters deal with measurement and utilization, including felling and extraction, marketing, conversion and preservation. Chapter 11 covers three special forest products: Christmas trees, rosin and turpentine (known in the United States as 'naval stores'), and maple sugar. This is followed by a chapter on the preservation of wild-life in forestry. Finally, two chapters are added covering 'forest plans' and records, and State aid to woodland owners. There are eight valuable appendixes on various subjects.

The book is well illustrated, with some excellent line drawings; but the quality of the photographs is not up to the standard one would expect. The text includes adequate headings, and is well tabulated. This book should be of great value in the United States, and is bound to be of much interest to anyone in Britain who wishes to increase and broaden his knowledge of forestry. N. D. G. JAMES

A STUDY IN CULTURE CONTACT

From Black to White in South Australia

By Ronald and Catherine Berndt. Pp. 313+5 plates. (Melbourne: F. W. Cheshire Pty., Ltd.; London: Angus and Robertson, Ltd., 1951.) 37*s.* 6*d.*

WITH few exceptions, the effects of European domination on any of the simpler native societies are fairly predictable—a period of mutual hostility, distrust and misunderstanding, the breakdown of the traditions, ties and sanctions that held the indigenous culture together, a further period of 'drifting' and general social maladjustment, and, finally, the very gradual absorption of the subordinate people into the lower strata of European society. Depending mainly on the cultures involved, this process may be accomplished with varying degrees of difficulty; but the history of Colonial development shows that it never has been, and perhaps never can be, entirely painless for the native peoples concerned.

In Australia, the difficulty experienced by the Aborigines in making the required transition was intensified by three factors. First, their small numbers; it has been estimated that the Aboriginal population has never been large, probably at no time exceeding half a million, scattered over the entire continent and living in small groups which were not accustomed to act in any organized unity. Second, although their religious and social structure was highly complex, technologically these people were among the most backward known. Finally, besides being, by European standards, physically unprepossessing, the Aborigines had an outlook and ideology which was, to the first settlers, foreign and 'barbarous' beyond any hope of understanding. The effect of these factors was that the Aborigines were able to offer no resistance to European settlement, which might have given them a 'breathing-space', however temporary; their absence of technology inspired the Europeans with a supreme and lasting contempt for their 'primitiveness', an attitude reflected in subsequent dealings with them; and, finally, the complexity and uniqueness of their social system not only made native adaptation to the new order excessively difficult, but also nullified most attempts at compromise made by the new-comers, so that humane intentions were often changed to exasperated bewilderment.

In their treatment of this problem, Mr. and Mrs. Berndt have restricted their discussion to South Australia, where they have selected four areas which typify four successive stages of the general Australian contact situation.

The first, Ooldea, is an 'outback' area. The natives of this district still retain, in modified form, much of their old nomadic tribal life, although they are becoming increasingly dependent on 'hand-outs' of government rations. The main source of contact here, however, is the United Aborigines' Mission, whose activities attract some extremely caustic criticism. With an earnest *naïveté* and a sense of values it were kindest to describe as 'misplaced', this body has made it a deliberate policy to condemn every aspect of native life, and, more seriously, to alienate, by every means in its power, the children under its control from their families and their tribal background. In return, it offers the Word; that the Word might Itself have meaning only in a particular cultural context does not seem to have occurred to them. The result of this disruptive policy is that the products of this Mission's training are left in a sort of cultural hiatus, severed from their traditional culture, yet not prepared for or admitted to European society.

The second district, Oodnadatta, is also an undeveloped area, but without mission influence. Here we see the process of acculturation beginning to take effect. The natives fall into three fairly distinct groups: labourers living in a squalid camp outside the town, disliked and despised by the Europeans; those living in the town (mainly women married to non-Aboriginal husbands) who form an amorphous section with no affiliations to either cultural group; and (the smallest section) women married to respected members of the town who enjoy an uneasy acceptance by the white community.

The third area carries the process a step further. The native population here is almost entirely mixed-blood and has attained the general living standard of 'poor whites'. The men are casual labourers, the women mostly prostitutes, and only traces survive of the old culture. The gradual infiltration to higher social levels continues.

In the fourth area, the city of Adelaide, acculturation is almost complete. Most of the people are scattered through a large slum area where they live on equal terms with their white neighbours.

The authors' treatment of this theme, while excellent so far as it goes, seems most suitable for the lay reader. The anthropologist who has not specialized in this area would like to know, for example, more about the nature of the native's ties to his 'own country' and why separation from it means degeneration and collapse; and more precise details of the modifications in the kinship structure, which, the authors inform us, is one of the last features of the old culture to survive. The book is a fairly adequate account of a situation, but the characters of the protagonists, which give the conflict its specific flavour, are insufficiently analysed.

The book is nicely presented, but contains a number of misprints, including two in section-headings (contents page and p. 125)—regrettable carelessness in a book published at this price. D'Arcy Ryan

FOOD FOR THE URBAN MASSES

Townsman's Food

By Dr. Magnus Pyke. Pp. 212. (London: Turnstile Press, Ltd., 1952.) 15*s*. net.

THIS is a readable little book, but whether it fulfils its objective "to try to describe for an intelligent and non-scientific reader some of the technical problems of modern food industry, and to examine the aims and purposes of its technique and policy" will be dependent on the degree of understanding of the non-scientific reader.

I am of the opinion that in describing some of the problems the author has achieved his object, that in his examination of the "aims and purposes" he is slightly less successful, and that in considering "policy" his contact with the Ministry of Food has biased his mind and that far too much space is devoted to war-time rules and regulations.

Whether such books are essential, whether or not they do any good, is a moot point. Certainly this publication has enabled both 'special correspondents' and learned academic people to write startling (and absolutely ill-informed) reviews in which the cunning methods of sophistication adopted by the modern food-manufacturer and the possible danger to the public are stressed out of all proportion.

To gibe at the food-manufacturer is popular these days, and in many places in the book there is a 'sting in the tail' of a sentence. For example, the author, on commenting on the colouring of margarine by the British manufacturer, says (p. 19), "is he then not contributing to the national nutrition if the colouring artifices he adopts to make his product resemble butter, succeeds in persuading people to eat it—even though these manœuvres were originally adopted to increase his sales, and hence his profits?" Artifices, manœuvres, sales and profits!

The use of glyceryl monostearate as an emulsifying agent is mentioned (p. 123): "... its employment in the food industry has been viewed with a certain element of thoughtfulness. Its development is closely related to progress in the field of soapless detergents". One feels that the author enjoyed writing such

paragraphs; he perhaps did it with his tongue in his cheek.

The chapters dealing with various groupings of food are well balanced; perhaps the section on bread is slightly too long, and in the section on milk the references to the unpasteurized versus pasteurized controversy would appear, in these days, to be archaic.

The author repeatedly stresses the difficulty of feeding a population such as that of the British Isles, with its congested urban districts, and gives full credit to the food technologist for making it possible to supply the people with food.

It is probable that the population in Great Britain has the purest food in the world, not excluding the United States, and one can agree with the author that the motives which stimulate the large food-manufacturer are (p. 203) "firstly honesty, and secondly enlightened self-interest".

The book is worth reading, if only to decide whether the reviewer is right or wrong.

L. H. LAMPITT

THE GLASS-POLISHER'S ART

Prism and Lens Making

A Textbook for Optical Glassworkers. By F. Twyman. Second edition. Pp. viii+629. (London: Hilger and Watts, Ltd., 1952.) 58*s*. net.

THE earlier edition of Mr. F. Twyman's book was one of the first important works in English to appear on the subject. Its value derived from the record of his wide experience; its weakness was that it was almost entirely confined to the methods of one factory. In the second edition the author has taken advantage of the co-operation he has received to extend its scope; in addition, there are a number of chapters (more or less connected with the subject-matter) contributed by experts. The size (and cost) have increased nearly fourfold.

Since the first edition the industry has become increasingly mechanized, and to this the diamond-bonded tool has largely contributed. The applications of this are well covered. The work of W. Taylor has been recognized, and the production and working of new materials have received adequate attention.

There are still a few (perhaps unavoidable) defects in the presentation of other manufacturers' methods. A little more information would be welcomed on the round-stroke polishing machine (only one type is illustrated) and the method of controlling figure, as is done for the straight-stroke machine. There is still rather much on the largely academic question of air-conditioning; though most firms find this unnecessary, and even in the working of the 200-in. mirror the elaborate plant devised was eventually abandoned.

There is much valuable discussion on grinding and polishing materials, and the author has endeavoured to introduce scientific precision. It would have been even more valuable if information about the sizes of abrasive powders of other manufacturers had been given. A new section deals with aspherical work, though this again is not quite complete as to range of work or methods of testing.

Two statements call for remark. One is that the author does not know of any machine on the market specifically designed for trepanning. Such a machine (of British make) was on sale between the two World Wars; the second is that an American surface generator has been constructed in which the whole sequence of operation is automatic. A British machine has also appeared (possibly while the book was in the press).

There are a few misprints and some omissions from the bibliography; the rather scanty section on tool-making could have been enriched by reference to the machines for milling optical tools, illustrated in W. Ewald's "Das Optische Werkstatt" (a work mentioned in the text). Surprisingly, no mention is made of the trichlorethylene degreasing plant for cleaning lenses, nor of the method of supporting lenses in recessed tools.

These are all minor matters in comparison with the wealth of information made available. The book is throughout delightfully seasoned by the author's personality, and he will be forgiven for riding his hobby-horses so hard.

H. W. LEE

THE AVIAN PITUITARY

The Structure and Development of the Avian Pituitary from a Comparative and Functional Viewpoint

By Karl Georg Wingstrand. Pp. viii+316. (Lund: C. W. K. Gleerup, 1951.) 18 kr.

DURING the past three decades there have appeared hundreds of papers dealing with the microscopic structure and the functions of the pituitary in various Chordates; but, comparatively speaking, little attention has been paid to the pituitary of birds despite its fundamental role in the evergreen study of migration and the timing of breeding seasons. This most acceptable volume from Sweden will be the standard work on the subject for many years to come, for Dr. K. G. Wingstrand has been at great pains to attain a comprehensive view of the class—from Rattites to Passerines—as a whole rather than draw conclusions from a single species: that is, the atypical, non-seasonal egg-laying machine, the common fowl, which is usually put forward as an adequate representation for 'The Bird' in biological literature.

The work comprises fourteen chapters and covers the anatomy and embryology of the adenohypophysis and neurohypophysis and compares them, in various aspects, with those of reptiles and mammals. The innervation, and blood vascular relationships, of the pituitary are considered at length, including the hypophyseal portal system which, though studied intensively in various groups during the past few years, has been curiously neglected in birds prior to the contemporary publications of Benoit, Walter and Assenmacher.

Dr. Wingstrand has seemingly confirmed the validity of the 'avian pituitary pattern' of Rahn and Painter and has, in fact, found the caudal and cephalic lobes of the pars distalis to be recognizably different in representatives of no less than fifty genera. He adopts a most conservative attitude in regard to the distribution of the various α and β cell-types and, it follows, to their probable functions. It is further noteworthy that although the subject of neurosecretion is briefly dealt with, the Golgi 'net-work' (whatever, precisely, it is) is not considered, nor is it dealt with in Dr. Wingstrand's lengthy cytological discussions.

A. J. MARSHALL

SIR WILLIAM RAMSAY (1852–1916)

By Prof. J. R. PARTINGTON, M.B.E.

THE present week marks the centenary of the birth on October 2, 1852, in Glasgow, of one of the most distinguished of the many famous British chemists, William Ramsay. Both his parents came from families of notable people; his paternal grandfather had been a chemical manufacturer in Glasgow, and his uncle on the father's side was Sir Andrew Crombie Ramsay the geologist. As a boy he showed already musical and linguistic talents; in later life, at scientific meetings abroad he spoke in several languages to suit the nationalities of those whose papers he was discussing, and in proposing toasts at more convivial gatherings he followed the same practice.

Ramsay's interest in chemistry developed in his student days at the University of Glasgow, but extramurally, since he had been educated for the ministry. In 1871 he went to Tübingen, where he took his doctorate, and on his return to Glasgow he became assistant in the chemistry departments of Anderson's College and then the University. His research work in this period was in organic chemistry, especially in relation to pyridine, an evil-smelling constituent of bone oil, stocks of which had been left in the cellar by a former professor, Thomas Anderson. His interest in physical chemistry (or, as he liked to call it, general chemistry) seems to have been aroused by E. J. Mills, then professor in Anderson's College (later the Royal Technical College). It was not until 1880 that Ramsay obtained his first professorial chair, at University College, Bristol. Here he showed another of his outstanding qualities, that of being an energetic and capable administrator, becoming principal of the College as well as professor of chemistry. His single demonstrator was Sydney Young, who later succeeded him as professor. Young was a very able experimenter and there is no doubt that he exerted a steadying and beneficial influence on Ramsay. Together they carried out work of outstanding importance on the vapour pressures and critical properties of liquids, which is still regarded as authoritative.

By now, Ramsay had become a chemist of international reputation. Always interested in teaching, he wrote in Bristol a small book, "Experimental Proofs of Chemical Theory for Beginners", on a very original plan. Another of Ramsay's traits was his open-mindedness towards modern theories; his early adoption of the Periodic Law as a basis of classification of the elements (which he adopted in his larger "System of Inorganic Chemistry", published in 1891), and of the theory of electrolytic dissociation at a time when it was bitterly criticized by most other chemists, are both good examples of his receptiveness and judgment. He also participated in the earlier developments of the electronic theory of valency.

In 1887 Ramsay succeeded Williamson as professor of chemistry at University College, London. At that time the College had become part of the University of London, but the latter was purely an examining body, having no concern with teaching or research. The conditions at University College were not so good as those in Bristol when he left it, and accommodation for research was practically non-existent. To some men such conditions are more stimulating and beneficial than succession to an 'institute' elaborately equipped and with a strong tradition of research in a special direction. Towards the end of Ramsay's life new laboratories, which in their time were models of what a university chemistry department should be, were erected; but all his important work was done in the old and modest accommodation. In 1888 he was elected a Fellow of the Royal Society, and in later life he accumulated a series of honorary degrees and memberships of learned societies which must be without parallel. He was a well-known personality both on the Continent and in the United States, numbering among his friends practically all the notable chemists of his time. His friendship with Ostwald, who did so much to further the cause of physical chemistry at a time when the preponderating interest was in organic chemistry, brought Ramsay into touch with a current of thought and of research which was changing the face of classical chemistry and must have influenced his own work.

Up to 1894 Ramsay's work was in the field of inorganic chemistry, in which he investigated oxides of nitrogen, and in physical chemistry, in which he investigated with Shields the effect of temperature on the surface tension of liquids, leading to the well-known equation of Ramsay and Shields and to a relation between surface tension and molecular weight. At University College also was carried out the work of Linder and Picton on colloidal solutions which is one of the foundation stones of modern colloid chemistry. It was in 1894, however, that Ramsay's great chance came. Lord Rayleigh was measuring the densities of gases and had found that nitrogen obtained from the atmosphere was appreciably denser than that obtained from chemical compounds. He suspected that the lighter nitrogen contained an unknown light gas, while Ramsay thought that the heavier nitrogen contained an unknown heavier gas. In 1894 he had a conversation with Rayleigh, who so far back as 1892 had asked chemists if they could solve the mystery, and in a very short time Ramsay was able to tell Rayleigh that by heating atmospheric nitrogen with magnesium, which combines with nitrogen, the residual gas was even heavier, suggesting that the heavier impurity in atmospheric nitrogen was a chemically inert gas. Even at that time Ramsay had realized that there was a possibility that the Periodic Table might be extended by a new group of gaseous elements, an event which he and his collaborators afterwards brought into being by the discovery of these elements.

Rayleigh was working on lines suggested by a forgotten experiment of Cavendish in 1785, who had found that on sparking a mixture of air and oxygen over potash solution the gas slowly disappeared and a solution of saltpetre was formed from the alkali and the oxides of nitrogen produced by the sparking; but always a small residue of gas was left, about a per cent of the original volume of the nitrogen. By his magnesium method Ramsay also obtained this inert gas, and at the meeting of the British Association in

1894 the two announced to an incredulous audience that the atmosphere contained a new gaseous element. Working independently, the two had reached the same result and the discovery was announced by them jointly. The full account of the work was given to a meeting of the Royal Society in January 1895. By then the density of the gas was found ; it had been shown to be monatomic from the ratio c_p/c_v of its specific heats as approximately 1·66, and its atomic weight was 39·9. The new gas was given the name 'argon'.

The day after the paper was read, Henry Miers, the mineralogist, directed Ramsay's attention to a gas evolved on heating uranium minerals and thought to be nitrogen. It might, he said, be argon. Ramsay prepared this gas, found that it gave a bright yellow line in the spectrum, and was inert. Crookes, with a sample of the gas sent him by Ramsay, identified the spectrum line with one which had been observed in the solar spectrum during the eclipse of 1868 by Lockyer, and supposed by him to belong to an element present in the sun to which he gave the name 'helium'. The new gas had, therefore, already been named. By the end of 1898 Ramsay, working with Travers, had discovered three more inert gases, neon, krypton and xenon, and with one exception the new group in the Periodic Table was filled. The remaining element linked this work with another field in which Ramsay made notable discoveries.

The year 1898, when the tale of the atmospheric inert gases had been told, saw the beginning of an epoch of scientific discovery without parallel in anything which had gone before. Radium was discovered by Mme. Curie. It was soon shown that radium emitted a radioactive gas called the emanation of radium (now radon). This was of great interest to Ramsay, who began work on the subject. His splendid manipulative skill, highly developed by having to deal with minute volumes of rare gases, was needed in handling extremely small quantities of radioactive emanation. In collaboration with Soddy, Ramsay soon showed that radon is an inert gas and that on standing it slowly changes into helium. In 1912 Ramsay and Whytlaw-Gray published the results of a determination of the density of radon in which only about a tenth of a cubic millimetre of gas was weighed on a micro-balance sensitive to two-millionths of a milligram. The atomic weight of radon found agreed with the assumption that it was formed from radium, atomic weight 226, by the emission of an alpha-particle which was chemically the same as a helium atom of weight 4 ; hence the atomic weight of radon should be 222, while the value 223 was found from the density on the assumption that it was monatomic. Radon then took its place as the last element in the inert gas group.

Ramsay's later work in the field of radioactivity was less successful and he was led astray by supposed transformations of elements, such as copper into lithium, under the influence of radioactivity. He realized, however, that the great concentration of energy made available in radioactivity was likely to lead to such transformations, a prediction achieved by later workers in this field. Ramsay took a great interest in the earlier applications of radioactive materials in medicine.

Ramsay was knighted in 1902 and his work on the inert gases gained for him the Nobel Prize in 1904. His administrative talent has already been mentioned, and during his tenure of the professorship at University College he was a president of the Society of Chemical Industry, of the Chemical Society, and of the British Association. He also took a keen interest in the character of the University of London, as a result of which and of the efforts of others, the University changed its former character of being a purely examining body and incorporated the constituent colleges as teaching institutions, at the same time giving their teachers a share in the examinations and the determination of the places of the candidates. Since then, the internal side of the University has greatly increased in importance and influence.

Ramsay had the keenest interest in research, inspiring his students and encouraging them by his example. Many of them have filled positions of distinction. At the end of the session of 1912 Ramsay retired from the professorship at University College. He was looking forward to the continuation of research ; but this was not to be. He died on July 23, 1916, after a painful illness.

Kindly and sympathetic towards his students, friendly and courteous to his colleagues, enthusiastic and active in his work, Ramsay left memories of a great man, which he undoubtedly was. After his death, funds raised by public subscription were partly devoted to the building of a Chemical Engineering Laboratory at University College and partly to the foundation of a Ramsay Memorial Fellowship for advanced students of chemistry. At present, owing to monetary depreciation, the number of fellowships has had to be reduced to half the original number, and the University College Committee and the Ramsay Memorial Fellowships Trustees decided that the centenary of the birth of Sir William Ramsay should be made the occasion of a joint appeal for a total of £100,000, partly to restore the number of fellowships and partly to extend the chemical laboratories at University College. Both these objects, it is believed, would further the interests of the extension of scientific knowledge which were Ramsay's interests, and also, since the fellowships are international in principle, are in harmony with his constant desire to advance friendship and helpful collaboration among all scientific men. The Appeals Secretary, Ramsay Centenary Appeal, University College, Gower Street, London, W.C.1, will receive contributions from all who wish to help this cause and will give further information about the appeal. The Science Museum, South Kensington, has also organized a Ramsay Centenary Exhibition in collaboration with University College, which was opened on October 2 by Lord Woolton, Lord President of the Council, and will remain open to the public for three months (see p. 562).

FACTORS AFFECTING CHOICE AND JUDGMENT

IT had been the intention to take advantage of the meeting of the British Association at Belfast to follow up the work of the informal conference on "Subjective Judgments" held in London in October 1950. It proved, however, to be difficult to realize this object within the present framework of the British Association, so that instead a series of papers were given which were not directly related to the work of the previous conference, the general title of the papers being "Some Factors affecting Choice and Judgment". Two of the papers, from the Road

Research Laboratory, Harmondsworth, dealt with social factors which affect the actions of road users; the other papers were of a more theoretical nature and dealt with factors affecting perceiving and judging under experimental, rather than everyday, conditions.

The attitude of the general science graduate to experiments involving subjective judgments is curious and illogical, even if understandable. He is taught throughout his study period to believe that those things which he measures during the course of his 'practical work' are facts, inviolable and true. His faith in them transcends the faith of religion. Above all, he believes in the dogma of Kelvin, that we must measure to be able to understand. He rarely succeeds in grasping the principles of uncertainty in physical measurement, and many years may pass before he realizes that all measurement demands a judgment on the compromise between accuracy and expediency. As a result, he dismisses all experiments which involve direct subjective judgments as being 'vague and inaccurate'. This dogmatic attitude is not confined to the young graduate. It finds its way into higher levels, where great efforts are made to develop physical analogues to supplant the human observer in a perceptual situation. Consequently, it happens that the experimenter who uses human subjects as indicators finds it necessary to go to unusual lengths to explain his means as well as his ends. Modern statistical methods have assisted greatly in the discipline of subjective judgment experiments. They serve in three ways: to enable the experiments to be designed on sound lines; to enable the results to be interpreted by a logical procedure rather than by inspection and induction alone; and to enable the results to be presented in a way which carries some conviction with the worker who believes that physical instruments alone can be used as indicators in experiments.

Statistical technique is a good servant, but an exacting master; it is appalling to contemplate the amount of observational and analytical work necessary to demonstrate statistically a factor the existence of which common sense has never had any reason to doubt. This must have struck forcibly those who participated in the Belfast symposium; but little improvement is likely to result until there is a change of heart in favour of a greater faith in the very real ability of human observers to give reliable judgments of their environment. The nature of this ability was demonstrated by Dr. R. G. Hopkinson, of the Building Research Station, Garston, who reported assessments of glare discomfort made under controlled conditions over a period of more than three years. With nothing to guide them but their sensations of glare discomfort, subjects had made settings of the physical variable controlling the sensation; the results showed only a very small variation in the mean values. Subjects who had passed through an initial 'sensitization period' could be relied upon to reproduce their findings to a useful order of repetition accuracy.

These findings apply to the conditions of a laboratory experiment. The work reported by the Road Research Laboratory was done under more natural conditions, records being made of the behaviour of road users, both drivers and pedestrians, to determine how this behaviour could be improved. The findings must be of interest to sociologists as well as to those concerned only with road safety problems. The work on driver behaviour suggests that improvement cannot result from legal restrictions alone unless there is a very great certainty of enforcement. Legal restrictions must be combined with clear evidence of the inevitability of enforcement, such as the presence of a policeman in a strategic position, or with clear evidence of the inevitability of physical retribution—drivers will stop at a "Halt, major road ahead" sign if there is clear evidence of the existence of fast traffic on the major road. The same effects are observable on pedestrians; a policeman at a crossing has a significant effect on those (chiefly men, it would appear) whose normal behaviour at crossings is irregular.

The effect of propaganda on the behaviour of both drivers and pedestrians could be demonstrated clearly; but propaganda alone is insufficient to maintain any permanent improvement. An example is that of the behaviour of both drivers and pedestrians on crossings. Propaganda alone improved behaviour at ordinary crossings, but not for long. But propaganda added to the striping of crossings in the zebra pattern produced a more marked effect, and one which remained, not indeed at the peak level attained during the initial stages, but nevertheless substantial.

These findings can be interpreted charitably on the assumption that the driver and pedestrian are sensible adults. A driver will not obey legal restrictions unless there are manifest reasons why he should. In the absence of visible evidence of retribution, he will behave as common sense dictates. He will not obey a speed restriction if there are no obvious hazards, nor will he stop at a road ahead if it is not likely to require such action. A pedestrian will not use a crossing unless it is clearly beyond his ability to get across the road without its aid. But equally the findings can be interpreted on the assumption that he is little more than a juvenile delinquent. This was the interpretation made in the paper by Mr. B. M. Foss, of Birkbeck College, London, with especial reference to the personality of the 'car-plus-driver'. On this interpretation the road user is anti-social, and will do any un-neighbourly action which he thinks he can 'get away with'. The car driver can be expected to enlarge his 'body-image' in relation to the size and horse-power of his car, just as a man with a hat allows for his increased height in going under a low doorway. The body-image governs behaviour in a social as well as a physical sense. The driver with a large car finds himself in a position of power, and his tendency is to exercise it to his own advantage, unless he is warned, say by the presence of a policeman, of the inevitable retribution which such behaviour will bring.

There is a good reason for believing that much can be explained by the faith which the human subject has in his own abilities to make accurate judgments—a faith which, as has been suggested, is not shared by scientists nurtured in the nineteenth-century tradition. The pedestrian crosses the road without troubling to find a crossing, because he is sure that he can judge the distance and the speed of an oncoming vehicle, and hence is certain that he will be across before the vehicle can hit him. On the average his faith is justified, as the estimates given by the Road Research Laboratory show. But of course it is not the average man who gets knocked over. The distribution and variance of the speed estimates given by the work of the Laboratory show that there are occasions when the speed of an oncoming vehicle is

grossly underestimated. Mr. Foss directed attention to the fact that these lapses are more frequent in the neurotic and the fatigued; but many experiments, including those of the long series of judgments reported by Dr. Hopkinson, show that even the experienced subject will on occasions show a wide departure from his average judgment. If the 'average man' appreciated that his errors of judgment might on, say, one occasion in fifty involve him in a potentially fatal situation, he might exercise more caution—but equally he might still take the risk.

In any experiment or situation involving subjective judgments, the apparent inevitability of big random errors must not be neglected. If a large number of observers can make the judgment, these errors can be expected to cancel out. In practice it is often difficult or impossible to obtain sufficient observers; the work has to be done with a small team, and Dr. Hopkinson's paper dealt with some of the problems which arise in such a case. Experience of the experimental situation clearly has an effect. In the case of glare discomfort, there is a demonstrable increase in sensitivity from day to day, apart from the random errors. After this 'sensitization period' is passed, the subject appears to maintain his criterion of sensation over a very long period, with a fairly constant variance. It is therefore possible to decide the number of observations necessary from this observer in order to eliminate, to a predetermined degree of probability, the random errors in his observations. Consequently, an experiment employing a team of observers can be designed with a certain precision. It remains to link the results with those which would be expected to be obtained from a representative selection of the population under the same conditions. This has been done for a few of the important situations, and it has been found that about four-fifths of the general population are satisfied, or more than satisfied, with the average opinion of the team of experienced subjects. This applies, of course, to the particular problem of glare in lighting, but the same procedure is applicable to other perceptual situations.

The exact reason for this 'experience effect' in subjective judgments did not emerge from the discussion. It may be some form of accumulative memory-trace effect which should be capable of explanation. It might well link up with studies of modern information theory. The techniques of the Building Research Station experiments, which demand the control and variation by the subject of the physical variable governing the sensation, involve the feed-back of information of the situation, which must necessarily influence the judgment. These factors need study and explanation. The judgment is certainly influenced by the environment. This has been shown to be true in the judgment of spatial direction, as was demonstrated in the paper by Miss M. A. Phemister, of the Psychology Department, Queen's University, Belfast. There are preferred frames of reference, which assist judgment. If the body is vertical, the subject can judge position and direction accurately, but if it is tilted, this facility is to some extent lost. The apparent size of an object depends not only on the angular subtense of the object at the eye, but also on its position in the frame of reference. The moon near the horizon looks bigger than when well up, to such an extent that all kinds of explanations of the effect are made in terms of refraction distortions—another example of the inclination of some trained scientists to search for an objective rather than a subjective explanation of a phenomenon.

One would have hoped that some discussion would have arisen on the training of subjects to make judgments: whether such training is advisable, and if so, what form it should take. This important point was unfortunately not taken up. Mr. Foss, in his paper, gave a clear lead in his suggestion that 'intuition' is a facility that should be recognized as a valuable ability in clinicians and interviewers, for example, and that persons of good intuition should be found and trained, over and above the need, already recognized, for the training of subjects to make finer discriminations of a situation with greater accuracy. Dr. Hopkinson suggested that observers should have certain valuable personal characteristics. They should have a social conscience, and give of their best, without needing to be encouraged by a knowledge of the trend of their results—indeed, they must not have any preconceived theory about the experiment on which they are asked to make judgments; otherwise their 'coefficient of involuntary mendacity' may cause deviations or over-compensation. Their social conscience should extend only to a desire for the success of the experiment, and not to an interest in its result. Personal characteristics may also influence the kind of criteria which form the basis of the judgment. Mr. Foss suggested that some subjects may work better with broad categories; others may prefer to exercise their abilities to make fine discriminations within narrow categories, and hence these people may be suitable for different experiments from the former. This is a valuable and interesting suggestion which may merit close attention by those engaged on the development of the discipline of subjective judgment experiments.

R. G. Hopkinson

BOTANY OF FLAX

In introducing a meeting on the "Botany of Flax", held in Belfast on September 8 by Section K (Botany) of the British Association, Major G. O. Searle, of H.M. Norfolk Flax Establishment, referred to the importance of the flax plant as a major factor in building up the prosperity of Belfast and Northern Ireland in general. Although in Ernst Schilling's "Die Faserstoffe" more than nineteen hundred plant species are listed as being capable of yielding fibre of industrial use, the best of all—that is, *Linum* spp.—were utilized in the Middle East seven thousand years or more ago. It has been suggested by some that *Linum angustifolium* Huds. was the species first used for the manufacture of linen; but it is clear that for many centuries *Linum usitatissimum* L. has held the field; the taller fine-stemmed varieties are used for the production of fibre, and the shorter branching-varieties for linseed. The chief interest of linen flax lies in its fibre system and in the attempt to produce improved types by breeding, the quantity and quality of the fibre being the salient factors concerned. From 1880 onwards, flax growing in the British Isles has been mostly centred in Northern Ireland where, owing to the practice of 'dam retting', the seed is lost. Consequently, all sowing seed was imported from Russia and the Baltic countries or from Holland. Distinctive varieties as such were not available, and the brands of seed largely used were known as Riga

or Pernau Crown. Often the seed was first imported into Holland, where it was grown once, and the produce exported to Northern Ireland as Riga Child or as Dutch seed under a merchant's brand. Some of these brands were exceptionally good; but they are not now obtainable owing to the changed conditions of flax culture in Russia and the Baltic countries since the Revolution of 1917.

Planned flax breeding was commenced in or about 1911 by the Department of Agriculture in Dublin and by Vargas Eyre at Wye College, Kent. Eyre had visited Russia and the Baltic countries in that year and had brought back seed from some of the best flax districts. These stocks were maintained in England until 1920, when they were taken to Northern Ireland and made available for the flax breeding programme commenced by the Linen Industry Research Association at Lambeg. It was then known that taller varieties of flax could be isolated by single-plant selection from existing commercial strains, and the early work was based on this knowledge. In order to short-circuit the lengthy procedure of bulking large numbers of pure line selections for field and mill trials, Searle and Davin developed a section-cutting, staining and fibre-measuring technique for assessing the likely value of selected plants. As a result of this work, the well-known series of Liral varieties of fibre flax were produced. Liral Monarch and Liral Crown were single-plant selections from a Dutch brand of seed; Liral Prince was a hybrid between a Dutch selection and one of the original Russian strains produced in 1911; Liral Dominion, a selection from imported Riga seed, has been extensively grown in Canada, while a short but more resistant variety, Liral Duke, has given satisfaction in Egypt when grown on irrigated land. Similar success attended the work carried out at the Plant Breeding Station of the Northern Ireland Ministry of Agriculture, where such popular varieties as Stormont Gossamer, Stormont Cirus and Stormont Motley have been produced. Some promising varieties have appeared on the Continent of Europe in recent years, but with the exception of Concurrent, a white-flowered flax which has been favoured by Continental growers for its standing and crop-yielding qualities, their popularity has not tended to be lasting.

Thus, during the past thirty years pure-line strains of flax have been produced which, according to the official trials, yield up to 50 per cent or more fibre per acre than the older commercial brands. Yet it is generally agreed both in Britain and on the Continent that the yields and grades of fibre are not so high as they were fifty years ago. The true explanation for this may lie in the inevitable decline in standards as fibre flax production slowly changed from a peasant handicraft to a semi-mechanized mill industry, and the outstanding problem is to devise ways and means for reversing this decline.

The future of flax breeding may be influenced by a study of yarn quality made in recent years by the Linen Industry Research Association. Here a significant correlation has been shown to exist between diameter and length of straw and spinning quality, indicating a relationship between fineness of straw and fineness of fibre. If it be assumed that fibre strands with fine ultimate fibres having thick walls and a small lumen are stronger than those having large ultimate fibres and a large lumen, then it would seem as if the search for strength may be linked with the search for fine quality, since the taller fine-stemmed varieties tend to have more and finer fibres and the thick-stemmed varieties coarser fibres with a tendency to a large lumen. These findings may be put to the test in trials with the three new purple-flowered varieties, Norfolk Earl, Norfolk Prince and Norfolk Mandarin, which appear to possess the characters required in the search for both quality and quantity of fibre.

In dealing with the question of seed health in relation to flax, Prof. A. E. Muskett, of Queen's University, Belfast, outlined the work carried out in Northern Ireland for the purpose of providing techniques for the examination of seed for contamination with fungal parasites. In the case of flax, this work culminated in the Ulster method for seed examination as a routine procedure, and in proving the effectiveness of tetramethylthiuram disulphide as a flax-seed disinfectant. The disinfection of all sowing fibre flax seed produced in the United Kingdom has now become routine practice. The availability of the Ulster method allowed a health survey to be made for flax seed produced throughout the United Kingdom, and the survey has now been carried out for a period of ten consecutive years, three to four thousand seed samples being examined each year. The results may be expressed as follows.

(1) (*a*) The incidence of the fungal seed-borne parasites *Colletotrichum linicola* Pethybr. and Laff., *Polyspora lini* Laff. and *Phoma* sp. is highly significant in the northern and western areas of the United Kingdom. It is insignificant in the southern and eastern areas. (*b*) The incidence of the fungal seed-borne parasite *Botrytis cinerea* Fr. may be significant in flax seed produced in all areas of the United Kingdom. Its incidence tends to be highest in seed produced in some coastal areas.

(2) The results show clearly that seed contamination occurs much more readily in the wetter and cooler northern and western areas than in the drier and warmer areas of the south and east, where no build-up of parasitic fungi, with the exception of *Botrytis*, has been observed over a period of ten years. Rainfall, in so far as it may encourage a continuously humid atmosphere, is probably the major factor leading up to seed contamination, with temperature conditions playing their part.

(3) Investigations over a ten-year period show that the area to the south and east is well suited for the production of supplies of healthy flax seed of good quality. The remainder of the country is not suitable for seed production.

The results emerging from this survey show the possibilities which might emerge from similar surveys carried out not only in the United Kingdom but also on a world-wide basis with seeds of other agricultural and horticultural crops, with the object of ensuring supplies of seeds and planting stocks of proved good health. Such work might be of very great benefit in the more backward regions where so much still remains to be done to ensure more bountiful supplies of food and raw materials.

In presenting a paper on the physiological specialization of *Melampsora lini* (Ehrenb.) Lev. by Dr. A. G. Arif (formerly a research student of Queen's University, Belfast, and now in India), Dr. J. Colhoun, of Queen's University, said that studies of the reactions of sixteen differential flax varieties to pure cultures of *Melampsora lini*, the causal organism of flax rust, collected in various parts of the United Kingdom had resulted in the recognition of sixteen

physiological races of the parasite. Six of these races have already been recorded in North America or Europe; but the others are believed to have been hitherto unrecorded. One new race was also isolated from diseased flax sent from Pakistan. All the races found occurring in England, Scotland or Wales have been recorded as occurring in Northern Ireland. All the fibre varieties of flax commonly grown in the British Isles are susceptible to all the British races of the fungus. The fibre varieties, Textilshchik, U.S.S.R. No. 2, 1288/12 and Stakhanovets, developed for rust resistance in the U.S.S.R., as well as the rust-resistant variety Wada, bred in Australia, proved immune to all the British races. These results show substantial agreement with those previously obtained in Northern Ireland for the reaction of these varieties in the field, with the exception that 1288/12 was susceptible in field trials in certain years. It is suggested that the difference between the results of field trials and those where known races of the fungus were used for inoculation purposes may be attributed to more races being involved under field conditions than have yet been differentiated. These studies demonstrate that resistant varieties exist to provide the basis for the production of varieties which will combine the quality of rust resistance to British races of the parasite and high yield of good-quality fibre.

The important problem of weed control in the flax crop was dealt with by Mr. K. Holly, of the Oxford Unit of Experimental Agronomy, who emphasized the fact that flax cannot compete effectively with aggressive or perennial weeds. As it is the fibre in the stem of the flax plant which is the economic product, the use of selective herbicides for flax must be carefully studied for adverse effect on the straw as well as for effectiveness of weed control. In the course of experimental work with weedicides on crops in south and east England, sulphuric acid, ammonium sulphamate and ammonium thiocyanate were quickly discarded because of the excessive damage caused. Although, at equivalent dosages, cupric chloride had more adverse effect on flax than cupric sulphate, from three to five times as much cupric sulphate was needed to give a comparable degree of weed control. Dosages of cupric chloride of 10–20 lb./acre in 100 gallons of water had no adverse effect upon the yield of deseeded straw or scutched fibre at the 4–6-in. growth stage. Sodium dinitro-*o*-cresylate could be used at 6 lb./acre before the flax is 10 in. high without undue risk, and approximately the same finding held for the sodium salt of 2-methyl-4-chlorophenoxyacetic acid used at 1 lb./acre. Experiments on weed-free crops showed that the safety limits for cupric chloride and sodium dinitro-*o*-cresylate were small, whereas they appeared to be greater for sodium methyl-chlorophenoxyacetate. Since 1945 the work has been confined to a comparison of the effectiveness of commercial formulations of the sodium salts of 2-methyl-4-chlorophenoxyacetic acid and 2.4-dichlorophenoxyacetic acid. The use of the sodium salt of the methyl-choro compound at 1 lb./acre or less, with a maximum resistance when the crop was 4–6 in. high, was found to be safest for the variety Liral Prince. With the advent of low-volume spraying, further experiments showed that this method entailed a greater risk of damage than medium- or high-volume applications. The results of the work considered as a whole suggest the recommendation of the use of sodium methyl-chlorophenoxyacetate for weed control in the flax crop in England. A dosage-rate of $\frac{1}{4}$ lb./acre should not be exceeded, and it should be applied between the cotyledon stage and the attainment of a crop height of 6 in. Low-volume spraying is probably undesirable. These findings are not altogether in keeping with those for other countries, and, although the reason for this is not clear, it may be concerned with the flax variety grown. Apart from weed control, the effect of synthetic growth regulators upon the anatomy of the flax straw and the consequent effect upon the yield of fibre suggests a most interesting field of study.

In opening the discussion, Mr. E. V. B. Wilson, of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland, suggested that selection in flax is not aided by any known correlation of desirable economic characters with any constant and easily observable morphological characters, and that none of the nine standard Russian flax varieties is satisfactory for all economic requirements. Unfortunately, this also holds for the United Kingdom, where work by plant pathologists in Northern Ireland has shown that the popular modern varieties of fibre flax are very susceptible to disease generally and probably more so than the older brands referred to by Major Searle. Mr. Wilson was of the opinion that breeding for disease resistance in flax and other crops is most essential and that the closest co-operation between the breeder and plant pathologist is highly desirable. Dr. J. Ramsbottom emphasized the sudden character changes liable to occur, particularly in the parasite, which may render a resistant host-plant susceptible. A good example of this, he said, is presented by the cereal rusts; but it is a problem which has to be faced. Prof. Muskett said that one hopeful aspect of the work on flax rust in Northern Ireland is the fact that one or more of the Russian flax varieties used has shown immunity to all the physiological strains of the parasite employed. With regard to resistance to flax wilt, Major Searle pointed out that tests made in Northern Ireland show the variety Norfolk Queen to be highly resistant to this disease.

Further discussion was debarred owing to the shortage of available time, but it is clear that the meeting did much to bring to light the difficulties facing the breeder of improved flax varieties, especially in view of the changing methods adopted in the linen industry. It also showed the desirability of producing seed in areas where the seed-borne disease factor is relatively unimportant, and for disease resistance to be taken into account by the breeder. Although a considerable advance has been made in the investigation of spraying with selective herbicides for weed control, the solution of this problem still awaits completion.

OBITUARIES

The Right Hon. Lord Robinson, O.B.E.

By the sudden death in Canada on September 5 of Lord Robinson of Kielder Forest and Adelaide, Great Britain has lost its foremost forester. An Australian by birth and early upbringing, he was one of the first of the Rhodes Scholars and seldom, indeed, can the Rhodes Foundation have made a better choice. His academic forestry knowledge was acquired under that wise old forester, Sir William Schlich, then professor at Oxford, of whom Robinson often spoke in later days with affection and respect.

A public servant since 1909, the whole of Robinson's long career was devoted to the cause of British forestry. The Forestry Commission, of which he was successively technical commissioner and chairman, owed its existence and policy very largely to his initiative and organizing ability.

Made a peer in 1947 in recognition of his outstanding services, he was the first forester to receive that honour. Characteristically, he took his title in part from the Border Forest of Kielder. The largest of the new forest blocks of his creating, it was also the one of which he was the most proud, partly perhaps because it exemplified the wisdom of his policy of proceeding step by step from the known to the unknown. It was not until the success of the pioneer afforestation at Smales in the Kielder area was reasonably assured that he agreed to the acquisition of the further large blocks which now comprise Kielder and the adjoining forests in the Border country.

Robinson's extensive tours of the forests in Great Britain and throughout the Commonwealth, as well as in many parts of Europe, reinforced by a remarkably retentive memory, gave him a uniquely wide experience of all branches of forestry. It was this wealth of experience which made him such a stimulating guide in the forest.

Robinson's approach to sylvicultural problems was essentially scientific, and although administrative work took up a large part of his time, his own contributions to our forestry knowledge were of no mean order. We owe to his fertile mind the highly original basis of the construction of our British yield tables which were built up from the measurements of 1,000 sample plots recorded in woodlands in the process of being felled during the First World War. Had it not been, too, for his foresight, all record of the rate of growth of these woods would have been irretrievably lost. Moreover, he was probably the first forester in any country to realize the importance of statistical lay-outs and analysis in field experimentation; in the early 1920's, he enlisted the aid of R. A. Fisher, then at Rothamsted, in order to ensure that the techniques being developed there for agricultural experiments were applied also to appropriate problems in forestry.

Lord Robinson's fine physique and handsome presence made him a conspicuous figure in any gathering. Inclined to be austere in the office, his reserve melted almost magically as soon as he got among his trees, when he was extremely good company. It was not until about two years ago, when an accident on one of his inspections of the Border country led to a serious illness, that he was obliged to curtail his outdoor activities to some extent; though even then he continued to cover an astonishing amount of ground, using a 'land rover' to get about over the forest tracks.

His many-sided gifts showed perhaps to the greatest advantage when he was presiding over a large meeting. Those who attended the Empire Forestry Conference held in South Africa in 1935 will long remember the tact and imperturbable good humour with which he conducted its affairs. It was while attending, as head of the British delegation, the Sixth Commonwealth Forestry Conference in Canada, that a sudden attack of pneumonia proved fatal. So at the height of his fame and almost at the end of his long and honourable career in the public service, a great man has departed; the nation is the poorer for his loss.

W. H. Guillebaud

Sir Frederic Kenyon, G.B.E., K.C.B.

Sir Frederic Kenyon, who died on August 23, gave forty-one of his eighty-nine years to the service of the British Museum. For the last twenty-one of them he was director and principal librarian. Born in 1863, the seventh of the fifteen children of John Robert Kenyon, Q.C., he laid the foundations of his classical learning as a scholar of Winchester and of New College, Oxford. First-classes in Moderations and in *Literæ Humaniores* led to a fellowship at Magdalen in 1888, and a year later he won the Chancellor's English Essay prize. In 1889 he entered the Department of Manuscripts of the British Museum, where he devoted himself to the cataloguing of the extensive and increasing collection of papyri. It was virtually an unworked field and a particularly attractive one for a brilliant young scholar. He made his name two years later by the discovery, publication, and translation of Aristotle's lost treatise on the Athenian Constitution. The text of this was edited for the Berlin Academy in 1904 and for the Clarendon Press in 1920. Other discoveries among the literary papyri were the Mimes of Herodas, an unknown speech of Hyperides, and twenty odes of Bacchylides, the latter from a roll acquired by the Museum in 1896. In 1899 appeared his well-known "Palæography of Greek Papyri". Other fruits of his scholarship were the "Catalogue of Greek Papyri in the British Museum" (vol. 1, 1893; vol. 2, 1898; vol. 3, 1907) and "Facsimiles of Biblical Manuscripts in the British Museum", published in 1900. In addition to these official labours, he published in 1895 "Our Bible and the Ancient Manuscripts", a classic in this field and many times reprinted.

In 1909 he was chosen to be director of the British Museum at an unprecedentedly early age and in preference to not a few colleagues of senior rank and of great eminence in their different fields. It was a difficult situation calling for exceptional tact and wisdom. These qualities Kenyon possessed to the full, and with them urbanity, fairness, and administrative ability of the highest order. Never was the Museum more wisely and fairly governed; never had its prestige been raised to a higher level. Classical studies had sharpened his critical faculties, enabling him to lay bare with penetrating clarity the essentials of the most difficult problem. His capacity for business, coupled with firmness and courtesy, made him a model chairman, and he was at various periods president of the British Academy, of the Hellenic Society, of the Society of Antiquaries, and warden of Winchester College. In 1918 he was selected as adviser to the Imperial War Graves Commission.

After his retirement in 1930, Kenyon gave himself largely to biblical studies, an early love, and to textual criticism in particular. He edited a series of biblical papyri which Mr. Chester Beatty had brought from Egypt, publishing the fruits of his labours in "Recent Developments in the Textual Criticism of the Greek Bible". To this work, produced in 1933, he added in 1948 "The Bible and Modern Scholarship", small in size, but weighty in content. A work of more popular appeal but not less scholarly was his "Books and Readers in Ancient Greece and Rome", which had appeared in 1932.

He was an honorary graduate of many universities. Many honours and decorations had fallen to him; but it is probable that he prized none more highly than the T.D. which marked his long connexion with the Territorial Army and with the Inns of Court Regiment

in particular. Beginning the First World War as a company commander, he ended it as a lieutenant-colonel. Had he not chosen the path of scholarship, Kenyon might have been a soldier of distinction. He touched nothing which he did not adorn.

He married in 1891 Amy, daughter of Rowland Hunt. She died in 1938. Of his two daughters the elder is a well-known archæologist.

F. G. RENDALL

Dr. William McRae, C.I.E.

WILLIAM MCRAE was born in Scotland in 1878 and graduated in the University of Edinburgh, from which he later received the degree of D.Sc. He arrived in India on March 28, 1908, and joined the Agricultural Service as a mycologist at the Imperial Institute of Agricultural Research, Pusa, now the Indian Agricultural Research Institute, New Delhi. Dr. McRae's services were placed at the disposal of the Government of Madras with effect from January 1, 1910, for employment in the local Agricultural Department, where he served for nine years as Government mycologist and as the principal of the Agricultural College. During the period of his tenure in Madras he developed both mycological research and teaching. He successfully conducted campaigns against the serious disease of palms which is responsible for bud-rot. Earlier he also investigated the blister blight of tea which was responsible for heavy losses in tea plantations in Darjeeling, and published an extremely valuable bulletin on the subject, in which he described the control measures of this serious disease.

In 1920 Dr. McRae returned to Pusa as head of the Mycological Section of the Imperial Institute for Agricultural Research, a post which he held until the end of his service, except for intervals when he acted as agricultural adviser to the Government of India or as agricultural expert to the Indian Council of Agricultural Research. He was responsible for valuable investigations on the wilt disease of pigeon-pea, the mosaic disease of sugar-cane and also foot-rot of betel vine. He held the posts of joint director and that of director of the Imperial Institute of Agricultural Research, Pusa, in addition to his own duties, for short periods.

Dr. McRae made valuable contributions to the investigation of plant diseases and published more than twenty-one scientific papers. In recognition of his work he was appointed C.I.E. in 1934. He was placed on the retired list after more than twenty-five years service on June 23, 1934. He was one of the most energetic men in the Indian Agricultural Service, and besides being an able scientist he also had the reputation of a good administrator and a great disciplinarian, who spared no pains in the development of mycological research and kept up the standards so well established by Dr. E. J. (later Sir Edwin) Butler, whom he succeeded. In Dr. McRae's death on July 8, India has lost not only an outstanding scientist, but also a friend who will be held in esteem for a long time to come.

R. S. VASUDEVA

The Right Hon. Lord Macmillan, G.C.V.O.

MR. W. D. STURCH, secretary to the Royal Commission for the Exhibition of 1851, writes: "Lord Macmillan, who died on September 5, was chairman of the Board of Management of the Royal Commission for the Exhibition of 1851. He took a close personal interest in the Commissioners' scheme of science research scholarships, and those who were present at the 1851 Scholars' Centenary Dinner in 1951 will surely remember him with affectionate respect. His great humanity enabled him to see scientific achievement in a true perspective, and he was not afraid to remind a gathering of distinguished scientists that they were first and foremost human beings. He was intensely proud of the scientific record of the Commissioners' research scholars, and maintained his active interest in the work of the Royal Commission until the day of his death. Scientists may well join with those in many other walks of life in mourning the loss of a great friend".

WE regret to announce the following deaths:

Prof. C. B. Fawcett, emeritus professor of geography in the University of London (University College), on September 21, aged sixty-nine.

Mr. E. H. Godfrey, formerly chief of the Agricultural Branch, Dominion Bureau of Statistics, Canada, on September 22, aged ninety.

Prof. C. H. Lees, F.R.S., emeritus professor of physics in the University of London, formerly vice-principal of Queen Mary College, on September 25, aged eighty-eight.

NEWS and VIEWS

Emil Fischer (1852–1919)

EMIL FISCHER, who in his life-time exerted a profound influence on chemistry and chemists of his generation and whose discoveries in biochemistry are still yielding rich harvests, was born a century ago, on October 9, 1852, at Euskirchen in Rhenish Prussia. The son of a prosperous merchant, he was apprenticed for two years to his brother-in-law, a timber-merchant, on leaving school in 1869. His interest in experimental science led to his becoming a pupil of Friedrich August Kekulé at Bonn. After working as assistant to Adolf von Baeyer at Strasbourg and Munich, he held the chairs of chemistry at Erlangen and Würzburg, and in 1892 succeeded August Wilhelm von Hofmann as professor of chemistry at Berlin. As early as 1875 he discovered phenylhydrazine, "the path-finder of carbohydrate chemistry", and described its reaction with the sugars to form osazones. He synthesized and formulated caffeine, xanthine, theobromine, glucose, fructose and veronal—the first of the barbiturates; developed a 'family tree' of gout, based on the purine nucleus; devised quantitative methods for isolating amino-acids, with which he prepared polypeptides; and, with Emil Abderhalden, did fundamental research on the specific action of enzymes. Keenly interested in the requirements of the chemical industry, he was instrumental in founding the Kaiser-Wilhelm Institut für Chemie in 1912 and in the First World War organized Germany's chemical resources. A tremendous worker with a splendid memory, Fischer was idolized by his

pupils and assistants, once they had accustomed themselves to his austere manner and to his exacting and critical methods. Elected a foreign member of the Royal Society in 1899 (he had been awarded the Davy Medal in 1890) and recipient of the Nobel Prize for Chemistry in 1902, he died during the night of July 14, 1919.

An Elizabethan Lodestone

The National Maritime Museum, Greenwich, has recently been lent a lodestone reputed to have belonged to Sir Francis Drake and to have been given by him to Lawrence Kemeys. The lodestone is mentioned in an inventory of the possessions of the Kemeys family so far back as 1630, and has been handed down in the family to Lord Wharton, its present representative, by whose permission it is being exhibited in the Museum. It is approximately 1 in. by 1 in. by $\frac{5}{8}$ in. and is believed to have been reset in silver about 1700. The lodestone is of the type formerly carried by sea-captains when on long voyages in order to 'retouch' the compass needles when they became demagnetized. This one is extremely strong, having a magnetic moment of 1,900 c.g.s. units. Lawrence Kemeys came of the Kemeys, or Kemmeys, family of Cefn Mably House, Michaelstone, near Cardiff, and the earliest record usually quoted of him is his command of the *Gallego* under Sir Walter Raleigh during his voyage to Trinidad and up the Orinoco in 1595. He seems to have shared for a time Raleigh's imprisonment in the Tower of London in 1603, and was foremost in urging the undertaking of the latter's ill-fated expedition to the Orinoco of 1617.

Ramsay Centenary Exhibition

An exhibition at the Science Museum, organized in collaboration with University College, London, marks the centenary of the birth of Sir William Ramsay (see p. 554); it will be open for three months. The Exhibition is divided into three main sections: the first will include books, documents, portraits and general biographical material. A large oil painting of Ramsay, made by Mark Milbanke in 1913, will form a fitting centre-piece. In the second group will be seen some of the original apparatus used by Ramsay and his collaborators. One of the earliest machines for obtaining liquid air, which was installed for Ramsay in 1898, has been re-erected for the exhibition. The third group illustrates the way in which the inert gases now serve our needs.

Incubation and Hatchery Practice

Every year in England and Wales about 100,000,000 poultry eggs are used for hatching purposes; of these, about 30 per cent fail to hatch. Failure to hatch may be due to unsatisfactory nutrition of the breeding flock or it may be due to some fault of the hatchery incubating the eggs. Whatever the cause, a 30 per cent loss represents a heavy charge on the poultry industry of Britain. Of equal or greater importance may be the effect of unsatisfactory hatching conditions on chicks which do survive any mismanagement at the hatchery. They may be affected to a degree which may adversely influence their ability as egg producers, and these poor-quality birds will remain an additional handicap on the poultry industry. To help poultry farmers the Ministry of Agriculture and Fisheries has produced a booklet which deals with the hatchery industry in considerable detail. The opening section describes the structure of the egg and the development of the embryo chick. Natural hatching and artificial incubation are then dealt with, and hatchery design, construction, hygiene and management are also described. A chart summarizes all the possible causes of hatching failure and how to avoid them, while the special requirements of turkey, duck and goose eggs are listed in an appendix. Copies of the bulletin may be obtained from H.M.S.O., price 1*s.* 10½*d.*

Detection of Insects in Grain

To reveal the extent to which a sample of grain is infested by insects and the nature of the insects concerned, a prolonged investigation in the laboratory which may take several weeks is required. But there is frequent need for some rapid method by which the presence or absence of living insects can be recognized, so that an immediate decision may be reached as to whether the grain in question is suitable for prolonged storage. Similarly, in stores receiving supplies from various sources, testing of incoming batches will prevent the addition of infested samples to the main stocks. The 'heating' of stored grain is a well-known sign of infestation, but a much more sensitive method for the detection of insects in grain is their production of carbon dioxide. At or below 15 per cent water content, the metabolism of the grain itself or of any micro-organisms it may contain is negligible in comparison with that found even with a minimal amount of insect infestation. R. W. Howe and T. A. Oxley, of the Pest Infestation Research Laboratory, Department of Scientific and Industrial Research, have written a concise statement of the principles and applications of the carbon dioxide method in a pamphlet entitled "Detection of Insects by their Carbon Dioxide Production" (pp. 20; London: H.M.S.O., 1952; 1*s.* net). This describes the apparatus required, the test procedure and the interpretation of results, and includes all the tables needed for the analysis.

Agriculture and Forestry

A study of alluvial soils in north-west Germany from the point of view of combining alternate forestry and agriculture in a periodic or temporary agricultural use of forest land has been made by W. Wittich, and his conclusions have now been published in a brochure entitled "Landwirtschaftliche Zwischennutzung im Walde als Meliorationsmittel und Hilfe für die Ernährung" (temporary agricultural cropping on forest land as a means of soil improvement and as a supplementary source of foodstuffs) (Hannover: M. and H. Schaper, 1948) (see *Forestry Abstracts*, 13, No. 3; 1952. From the Commonwealth Forestry Bureau, Oxford). He reviews German, Austrian and Swiss literature on the subject, considering the varying characteristics of forest soils, the types of soil suitable for this purpose, the requirements of the agricultural crop plants that could be used, the practical management of such crops and the prospects for agricultural cropping on individual soil types, with main reference to the diluvial and alluvial soils of north-west Germany. He concludes that the widespread prejudice against this practice, one of the earliest practised by man, in part at least, is untenable; and he maintains that there are few soils on which agricultural use need be detrimental and many in which definite improvements could be achieved under proper treatment—for example, by the more intensive cultivation and fertilizing made economically possible by agricultural crops. This investigation,

which is of great value, is really only a throw-back to the method of 'shifting cultivation' and should have a far wider application than north-west Germany. The old-type shifting cultivation is being utilized in India and Burma, under its Burmese name *taungya*, by the forest officer to produce new crops of some of the more valuable species of timber trees; the practice is applicable to Africa and elsewhere in the tropics. But Wittich's work introduces a further most promising step to the problem of a world shortage of food. For the permanent forest areas of the world, which for various reasons it is imperative to conserve, can nevertheless be used for the growing of food crops for a pre-arranged number of years at the end of a forest rotation, and then the land can be returned to permanent forest. Such a system should substantially increase the amount of land available at any one time for agriculture.

West African Gold Coast Timbers

A SMALL handbook of Gold Coast timbers was first published in 1941; it proved of great utility to officers of the Forest Department and others concerned and was soon out of print. Since then, considerable progress has been made both in the assessment of the forest resources of the country and in the development of the timber trade. To meet a growing demand, it was decided to publish a new edition, a work undertaken by D. Kinloch and W. A. Miller, of the Gold Coast Forest Department ("Gold Coast Timbers." Revised Edition. Pp. xii+39; Takaradi: Government Printing Department; 1*s*. 6*d*.). Thanks are accorded to the Director of the Princes Risborough Forest Products Laboratory for assistance. The closed-forest zone of the Gold Coast occupies approximately one-third of the entire territory and has an area of some 30,000 square miles. The remaining northern two-thirds consists of the savanna-forest zone, the forest resources of which are of purely domestic interest. The timber wealth of the country is concentrated in the closed-forest zone, of which it is estimated that some 16,000 square miles are still under forest; the remainder has been converted to agriculture, which continues to destroy an estimated 300 square miles of forest every year. The forest is not uniform in type throughout, there being a gradual transition from the south-west corner in a general north-easterly direction, and this transition is intimately connected with rainfall, though other local factors occur. Two types occur: the tropical semi-evergreen rain forest of the south-west corner, and the tropical mixed deciduous forest covering some ninety per cent or more of the whole zone. Sub-types are proposed, and a number of species described for which the booklet should be consulted. The information given in this new edition is almost entirely the work of the Forest Department and includes considerable additional data provided by enumeration surveys and records of the Forest Products Research Laboratory, Princes Risborough. War-time departmental experience in milling and utilization has also proved of great assistance.

Proceedings of the Bihar Academy of Agricultural Sciences

THE first number of the *Proceedings of the Bihar Academy of Agricultural Sciences* has now been published. In view of the importance of agriculture in India to-day, this new journal should be a great asset, for research results, particularly those relating to local crops and climatic conditions, must be available to all concerned if progress is to be made on sound scientific lines. The subjects discussed in the first number are very varied, but in each case the emphasis is laid on the practical aspect of the problem. Among the biological papers are those on inter-varietal hybridization in *Luffa acutangula* and its economic significance, and studies in the production of carbon dioxide in stored wheat infested by *Sitophilus granaria* L. and *S. oryzæ* L. Soil and manurial problems are represented by a description of the Bihar soils, followed by an account of the results from a large number of field experiments carried out on cultivators' plots throughout the State. The benefit from the application of nitrogenous and phosphatic manures has been clearly demonstrated, and interest in their use so stimulated that appreciable increases in yields may be expected in many districts. The importance of statistics is evidently recognized, for the accuracy of field experiments is discussed in a further paper on the size and shape of plots in wheat trials. Three numbers of the journal will be published annually and these will be available free to members of the Academy; to others the annual subscription is Rs. 10. All communications should be addressed to the Secretary of the Academy, Agricultural Research Institute, P.O. Sabour (Bihar), India.

Newspaper Libraries in Great Britain

THE Library Association has published a pamphlet, entitled "Newspaper Libraries", by J. Lewis (No. 11 in the series; pp. 76; 1952. 7*s*., or 5*s*. to members), which outlines first the functions of such libraries in Great Britain and then describes the types of material contained in a newspaper library and the arrangement, classification and filing of such material. Some account is given of the news indexes maintained and indexing practice in newspaper libraries, of the methods used for the care and preservation of general and special material, and of the formal and informal co-operation which exists with other libraries. The pamphlet includes both a bibliography and index, and these facilitate reference to much information which may assist the technical or scientific librarian on occasion, as well as those whose needs are more general.

Manchester Museum: Annual Report for 1950–51

THE annual report of the Manchester Museum for the year ending July 1951 (pp. 28; from the Museum, Manchester; 1952) gives an account of continued progress in all departments. The housing of study and reserve collections has presented many problems, though by extensive movement of cupboards and cases a more orderly arrangement has been attained. The proper storage of collections involves classification, which is also an essential preliminary to cataloguing. One essential function of museums is research, and in this connexion it is interesting to note the large number of papers written by members of the staff during the year.

Fifth Empire Mining and Metallurgical Congress

THE fifth Empire Mining and Metallurgical Congress will be held in Australia during April 12–May 23, 1953, and afterwards in New Zealand. The Congress will afford an opportunity for mining engineers, metallurgists, scientific workers, engineers and others concerned with the mining and metallurgical industries to meet and discuss technical

progress and problems, including the development of the mineral resources of the British Commonwealth of Nations. The programme will be divided into five parts: pre-sessional visit in Tasmania (April 12–19); inaugural meeting and other official functions, together with technical sessions, in Melbourne (April 20–25); visit to Canberra (April 26–27); further technical sessions in Sydney and tours in New South Wales, South Australia and, if desired, Queensland or Western Australia (April 28–May 23); journey to New Zealand inspecting coal and mineral fields in South Island, followed by a conference in Dunedin and then visits to North Island. The main section of the technical proceedings will consist of a series of volumes dealing in an analytical and comparative manner with Australian deposits and practices, as follows: (1) geology of Australian ore deposits; (2) mining methods; (3) milling methods; (4) extraction metallurgy—(*a*) ferrous, (*b*) non-ferrous; (5) miscellaneous and general; (6) coal; and (7) general handbook. In addition, literature describing equipment and practices in the various important mining centres will be available. Further information about the Congress can be obtained from the Secretary, Fifth Empire Mining and Metallurgical Congress, Osborne House, 399 Little Collins Street, Melbourne, Victoria.

International Fertility Association

In Rio de Janeiro last year, delegates from twelve nations founded a new medical society to be known as the International Fertility Association. The aims of this organization are fourfold: to study the problems of fertility and sterility in their broad implications; to stimulate scientific investigation and social awareness in the field of fertility and sterility; to standardize nomenclature, terminology, tests and evaluation of diagnostic methods and therapy throughout the world; and to hold regular international congresses in different parts of the world. The first World Congress on Fertility and Sterility, sponsored by the Association, will be held in conjunction with the American Society for the Study of Sterility, in New York City in May 1953. Further information can be obtained from the secretary-general of the Association, Dr. Carlos D. Guerrero, Miguel E. Schulz No. 19, Mexico, D. F., or from the associate secretary-general, Dr. Abner I. Weisman, 1160 Fifth Avenue, New York, N.Y.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: C. A. Collins (inspector of plants and produce, Gold Coast), agricultural officer, Gold Coast: R. G. Heath (chief field officer, Federation of Malaya), deputy director of agriculture, Federation of Malaya; J. D. Jameson (senior botanist, Uganda), senior research officer, Uganda; R. G. Sangster (senior assistant conservator of forests, Uganda), conservator of forests, Tanganyika; Sir James Kirkpatrick (game ranger, Kenya), senior game ranger, Kenya; Z. Wolak (assistant livestock officer, Nyasaland), livestock officer, Nyasaland; W. R. Asfour, agricultural superintendent, British Guiana; D. R. Goodrich, agricultural officer, Nigeria; K. W. Harker, pasture agronomist, Agricultural Department, Uganda; T. E. F. Neavind, agricultural officer, Uganda; J. E. Huddart and C. Walker, veterinary officers, Kenya; D. A. B. Llewelyn, scientific officer, East Africa High Commission.

Announcements

Mr. Harold James Page, principal of the Imperial College of Tropical Agriculture at Trinidad since January 1947 (see *Nature*, **158**, 410; 1946), is resigning that appointment at the end of October in order to join the staff of the Food and Agriculture Organization of the United Nations.

The Lord President of the Council has appointed Sir Wallace Akers, a director of Imperial Chemical Industries, Ltd., and Sir Philip Johnson, a director of Hawthorn Leslie and Co., Ltd., and chairman of the Parsons and Marine Engineering Turbine Research and Development Association, to be members of the Advisory Council for Scientific and Industrial Research. Prof. P. I. Dee has retired from the Council on completion of his term of office. Sir Hugh Warren has resigned his membership of the Council because of the pressure of other duties.

The Council of the Institute of Metal Finishing announces that the Westinghouse Brake and Signal Co., Ltd., Prize is to be awarded to Mr. W. A. Marshall for his paper on "Non-Electrolytic Smoothing Treatment for Steel". The Johnson Matthey Silver Medal has not been awarded this year, no paper in the field covered by the terms of the award having been received. The Medal is offered for a paper dealing with any aspect of electrodeposition of precious metals.

Sir Frank Whittle has been awarded the Churchill Gold Medal of the Society of Engineers. The award has been approved by Mr. Winston Churchill, who is an honorary fellow of the Society, and is made "for the most noteworthy development in engineering or contribution to contemporary engineering".

The reconstruction of the war-damaged buildings of Bedford College for Women (University of London) will be celebrated at a meeting in the College on October 28 at 3.0 p.m. Addresses will be delivered by the Chancellor of the University and the Principal of the College; Queen Mary, patroness of the College, hopes to visit the College during the afternoon.

Prizes of value up to £150, with a maximum of three awards, are being offered for 1953 by the Council of the British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund. The awards will be made for papers on original investigations in engineering and/or physical problems relating to compression, transfer or injection moulding. Further information can be obtained from the General Manager of the British Plastics Federation, 47/48 Piccadilly, London, W.1, to whom contributions for the prizes must be submitted not later than July 31, 1953.

An international congress on medical librarianship will be held in London during July 1953, with Sir Cecil Wakeley, president of the Royal College of Surgeons of England, as honorary president. The congress will include formal sessions for reading and discussion of papers, visits to medical libraries and social functions, and also, it is hoped, an exhibition of medical books and periodicals and library equipment. All those actively engaged or interested in medical librarianship are invited to participate. Further information can be obtained from the Honorary Secretary, First International Congress on Medical Librarianship, c/o London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

GOVERNMENT RESEARCH IN AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

THE third annual report of the Commonwealth of Australia Scientific and Industrial Research Organization*, which now numbers fifteen divisions and expended more than £3 millions during the year, covers the year ended June 30, 1951, and again stresses the extent to which slow progress with the building projects handicaps the development of research programmes.

In spite of staff problems, the Division of Soils continued work on some fifteen soil surveys and a compilation of a manual of Australian soils was nearing completion. Chemical work on the basaltic soils from Lismore, New South Wales, was completed, studies on the availability to plants of copper and manganese continued, and an investigation into the ion exchange and *p*H relations of cation-dominant soils commenced. Studies on the stability of naturally occurring aggregates have shown that natural aggregation can be measured by a drop-shatter method, which has been used to help define the structure and consistency of soils of the Riverina and Abermusden districts.

During the year, 518 samples of seed and plant material, chiefly pasture and forage plants, were introduced from thirty-three countries for trial in Australia, and in the latter part of the year the active collection of plant materials in other countries was developed with the view of testing in Australia. Further trials have confirmed the value of *Lathyrus ochrus* as a green manure for use in vineyards especially on lighter soils, and of *Phaseolus* as grain legumes, while studies of flowering and seed-setting of introduced sunflower varieties continued. A section of plant genetics has been re-established and its work extended to include genetical and cyto-genetical investigations of pasture species for Australian conditions, cereal problems not being pursued elsewhere, and problems in the resistance to disease of major vegetable crops such as the tomato and potato. The Plant Diseases Section has given special attention to the chemotherapeutic control of virus diseases, and investigations on the use of antibiotics for controlling plant diseases continued. Some six hundred further tests of native species were made for the presence of alkaloids, saponins, cyanogenetic glycosides and other chemical principles, and two hundred and fifty bulk samples were collected for more detailed examination. At Clare, Queensland, the two previous seasons investigations on the water requirements of tobacco showed that yield and quality were maintained over a wide range of treatments, and the effect of nitrogen-levels and rates of planting on quality was being investigated. Detailed studies of the nutritional requirements of subterranean clover are being continued under field, greenhouse and laboratory conditions; and other pasture investigations have included ecological studies on native and exotic pastures, nutrition and soil deficiencies, the use of pastures and maintenance of fertility. Weed investigations again indicated that plant-growth regulating substances alone offer no prospect of controlling established skeleton weed (*Chondrilla juncea*). At the Katherine Research Station, the lime-stone red soils of the Tipperary land system were being examined for determining the possibilities of agricultural development under dry-land conditions, while at the Kimberley Research Station agronomic and pasture problems under irrigation were being studied in co-operation with the Western Australia Department of Agriculture.

Research into problems of animal health and production at the McMaster Animal Health Laboratory, Sydney, included further studies with phenothiazine against internal parasites. Studies at the Veterinary Parasitology Laboratory, Yeerongpilly, Queensland, on the identification of the species of amphistomes infesting cattle have been completed, and evidence obtained that the 'Queensland itch' of horses is associated with hypersensitivity to the bites of sand-flies (Ceratopogonidæ); protection by regular spraying with DDT was being investigated. Progress is reported in the development of the Poultry Research Centre at Werribee, Victoria, and studies of the vitamin A requirements of sheep, the effects of zinc and copper deficiency on the biochemical processes involved in phosphorylation within the tissues of plants, on carbohydrate metabolism, and on sheep feeding with particular reference to drought conditions continued, as well as on the influence of nutrition on the breeding performance of merino ewes.

Besides its work on the cattle tick, the Division of Entomology obtained very promising results in co-operative work on the control of the Argentine ant in Sydney and in Western Australia, which points to the possibility of complete eradication of the ant. The expected outbreak of the Australian plague locust did not materialize during 1950–51, and earlier work on the relation between trees and locust abundance was extended. A long-term experiment on the control with DDT of the pasture cockchafer, *Aphodius howitti* Hope, was concluded; but use of DDT against the red-legged earth mite in pastures also infected with the lucerne flea (*Sminthurus viridis* L.) is not recommended. Work on biological control has emphasized the importance of detailed attention to the flora associated with a weed, both to ascertain the extent to which other plants are likely to assist the insects and to determine the species likely to replace the weed. In the Wildlife Section, the work on the virus disease of rabbits, myxomatosis, was given priority, and the night-biting mosquito, *Culex annulirostris*, was shown to be the principal vector along the Murray main stream. Of poisons now in use, only sodium fluoroacetate showed promise for rabbit control.

Fisheries research at the Dunwich Field Station, Stradbroke Island, South Queensland, covered the distribution and movements of mullet in the estuarine and river phases of their history, the development of the oyster industry of Queensland, the distribution of prawns and preliminary work on lagoon fish-farming. The laboratory at Thursday Island, Torres Strait, was equipped and progress is reported in the study of plankton and the biology of pearl oysters. To extend the oceanographical work, preliminary plans were prepared for an oceanographical research vessel to be constructed in Great Britain. Studies on fouling by marine growths continued at various points, and this work has revealed the importation, on ships bottoms, of fouling organisms from other

* Parliament of the Commonwealth of Australia. Third Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June 1951. Pp. 167. (Canberra: Commonwealth Government Printer, 1952.) 9*s.* 6*d.*

countries. A programme covering the biology and distribution of *Macrocystis* aims at giving a reliable estimate of the quantity of this seaweed in Australian waters, the seasonal and long-term fluctuations in yield of the seaweed and its products, and the method of regeneration of the plant.

Food research included a detailed study of the performance of refrigerated railcars with end bunkers and coolers, which led to the preparation of a statement of the principles governing the use of these vehicles for chilled beef transport. An account of the work on the evaluation of canning processes was published. Studies of the temperature relations of *Clostridium botulinium* and of the factors affecting the germination of heat-treated bacterial spores continued, while much work was done on the development of rapid laboratory and field methods for estimating the degree of fish spoilage. The longer storage life of dehydrated sugared fruit compared with ordinary dehydrated fruit has been confirmed, and varieties of fruit and vegetables were being tested for suitability for freezing.

The anatomical studies of timbers from Malaya, Borneo and New Guinea have proved of considerable value, and attention has also been paid to the factors causing the death of medullary ray and vertical parenchyma cells in sapwood-heartwood. Activity in the wood preservation field markedly increased; a survey of the causes of failure of preservative treatment of cross-arms was completed in Western Australia, Victoria and New South Wales, and a laboratory study of the toxicity and permanence of water-borne preservatives was commenced. Research on the properties and uses of building materials continued in the Division of Building Research; but the only new project was the preparation of a paper on the weathering and durability of building materials in the tropics for the International Building Research Congress held in London in September 1951.

Wool textile research was extended to cover the improvement of wool as a textile fibre and the reduction of costs of production of woollen, worsted and felted materials, but several years must elapse before the new laboratories are fully staffed with adequately trained research workers. Considerable interest has been displayed in the two processes recommended by the Organization for the recovery of wool from sheepskin pieces and broken skins. A suitable method has been developed for the alkaline hydrolysis of wool wax to wax alcohols and acids, and the study of the formation of fibres under natural conditions has been continued in the Division of Industrial Chemistry, where much attention has also been given to the study of wool wax and sugar-cane wax. Steps were taken to provide a more comprehensive microanalytical service for scientific institutions and industry. Attention was also being given to analytical problems in connexion with the uranium ores of South Australia, the chemistry of alunite and its utilization in the production of potash fertilizers, the physiologically active alkaloidal principle of the Dwalganup strain of subterranean clover, and to liquid and vapour equilibrium concentrations of binary mixtures and their variation with temperature or pressure, in relation to plant design. A satisfactory method of concentrating topaz (used in ceramic ware) has been devised. The Section of Physical Metallurgy was concerned mainly with the metallography of alloys of titanium, gas surface reactions of titanium, and the influence of prolonged stress on lead alloys.

The work of the Division of Tribophysics continued on the same lines as in the previous year, but was still hindered by lack of space; and that of the Division of Metrology was largely determined by its statutory responsibilities for Commonwealth standards. The Division of Physics was also concerned with research designed to improve the accuracy of the methods of maintenance of standards, to increase the accuracy of measurement, the determination of properties of materials at extremely low temperatures and the study of the physical processes associated with the emission of radiation from the sun, including the development of new techniques for the study of the ionosphere and improved navigational aids under Australian conditions. The work of the Section of Meteorological Physics was consolidated and extended on the previous lines, including the prevention of frosts in orchards, the physics of rain and clouds, and the artificial formation of rain. In the Section of Mathematical Statistics two further centres have been established to provide direct assistance to divisions of the Organization in their experimental work. The Organization continues to co-operate with the Physics Department of the University of Melbourne in research on nuclear physics and cosmic rays under the direction of Prof. L. H. Martin.

AMERICAN SCIENTIFIC EQUIPMENT FOR BRITISH LABORATORIES

THE last report of the director of the Chemical Research Laboratory, Teddington, acknowledged the indebtedness of the Laboratory to the European Co-operation Administration of the United States for the supply of equipment unobtainable in Britain, including a Podbielniak Hyd-Robot self-recording low-temperature fractional-distillation unit, a Beckmann flame spectrophotometer and a multi-source unit for spectrographic work. A list of scientific equipment to the value of more than £350,000 made available in this way, chiefly to the Department of Scientific and Industrial Research, but also to some twenty-four other research institutions throughout the United Kingdom, has now been published*. The equipment, much of which is obtainable only in the United States, has been made available for a wide range of industries, and about three-quarters of it has already been received. It includes such diverse items as: an anderometer, enabling investigations to be made on precision bearings used in machine-tool spindles, etc., with the view of improving economy and quality of production; a compact surface analyser; a 'Falex' lubricant tester; multi-channel direct-reading spectrographs permitting the use of methods much in advance of existing rapid analytical technique; and a high-temperature dilatometer for research into moulding sand.

The National Physical Laboratory has been supplied with a set of valves for the construction of instruments for calibration in the frequency-range 2,660–10,000 Mc./s., a Carey recording spectrophotometer, a thallium boron-iodide prism, *K*-band klystron oscillators and crystal detectors, and with 'Fosterite' photoelastic material, as well as with nine Berkeley decimal electronic counting units. The Building Research Station has received two American explosive-actuated fastening tools as well as a portable

* Issued by the Industrial Correspondent, Mutual Security Agency, American Embassy, Grosvenor Square, London, W.1.

strain-indicator, while American 'trafficators' with magnetic counters and accessories will assist the Road Research Laboratory in taking traffic censuses. The Fuel Research Station has received a centrifugal molecular still, a Brabender semi-automatic moisture tester, a temperature-compensated Worden gravity meter and deep-sounding gear; and a special disk of metals not available in Britain will assist the Gas Research Board in furthering its fluidized bed technique for gasifying coal. The development of heat pumps has been assisted by the supply of a special small thermostatic expansion-valve, and in connexion with the generation of electricity from wind power special transducer valves have been supplied for gust recorders.

A Franz isodynamic separator has been supplied for the magnetic separation of minerals used in the atomic energy programme, and a small high-pressure pilot plant for catalytic flow-through experiments in organic synthesis. The work of the Shirley Institute has been facilitated by the installation of two Saco–Lowell speed frames and a ring frame, as well as a Scott serigraph for testing the strength of coarse yarns and light-weight fabrics. A special tensile testing instrument is being supplied to the Wool Industries Research Association, and a laboratory-type steamer, with pneumatically operated squeeze-rolls, to the Linen Industry Research Association. Other equipment supplied to research associations include the following: to the British Scientific Instrument Research Association, a Beckmann quartz spectrophotometer; the Motor Industry Research Association, a 'Stresscoat' equipment for stress analysis of crankshafts; the Pest Infestation Laboratory, American methyl bromide applicators; the Leather Manufacturers' Research Association, a Beckmann ultra-violet spectrophotometer; and to the British Paint, Colour and Varnish Manufacturers' Research Association, equipment to modernize a Perkin–Elmer spectrograph, a set of diffraction reference cards, and an automatic mixer for pigments and various media.

SURAMIN (BAYER 205) IN ANIMAL TISSUES

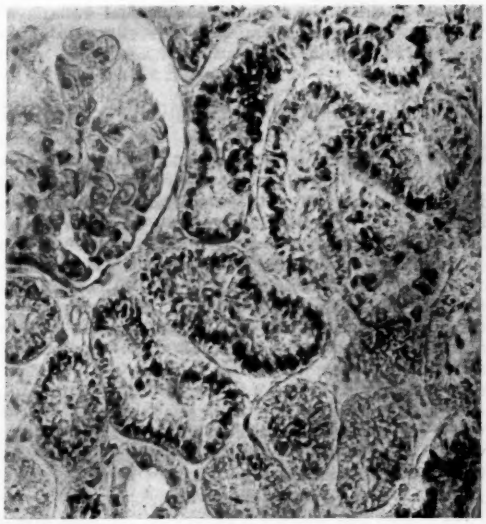
Demonstration of Bayer 205 (Suramin) in Tissues and its Cellular Distribution

THE purpose of our investigations was the elaboration of a histological method suitable for the study of the microscopic localization of suramin. Such a procedure seemed all the more desirable as this important chemotherapeutic drug is also, from a general theoretical point of view, an extremely interesting compound, owing to its being closely linked to proteins and its extremely long persistence in the organism (see refs. 1 and 2 for the literature).

Our experiments were based on the conception of combining the colourless sulphonic acid with a dye cation, thus rendering it visible. On the interaction of suramin and basic dyes in aqueous solution, coloured complexes are formed and, at a certain ratio of suramin to the dye, precipitation occurs, the same colloid chemical rules being valid as in the case of the interaction of acid and basic dyes having opposite electric charges. Among the quinone dyes with closed rings, several were found which could be also combined with the suramin present in the cells. Suramin could be 'stained' successfully with the following dyes: phenosafranin, cresyl blue, azure *B* (trimethylthionin). The best result was, however, obtained with methylene blue eosinate, which stained the cytoplasmic granules containing suramin deep violet; the nuclei were also faintly stained, and the counter staining of the eosine became visible too.

The essence of the specific staining technique is that a methyl alcoholic dye solution is used for fixing and staining simultaneously and, in contrast with routine histological methods, water is not employed, only organic solvents. A membrane cut from the connective tissue, omentum or mesentery is quickly spread out by means of pins on a slide, and, before drying, May–Grünwald stain is poured over it and left until it has nearly evaporated; then it is differentiated with continuous agitation in absolute ethyl alcohol for 20–30 sec.; the differentiation is interrupted with xylene, and the preparation is thoroughly washed in xylene and mounted in copaiva balsam. Smears of blood or exudate can be similarly stained as well as kidney tissue smears, in which the localization of the suramin in the nephron can be followed to great distances.

A second method is to place small pieces of organs in excess of May–Grünwald solution for about 10 hr. and then transfer them directly into benzene and embed them in paraffin; afterwards the sections are floated on slides, deparaffinized and mounted in copaiva balsam (see photograph).



Rat kidney 72 hr. after intravenous injection of 20 mgm. suramin. Granules containing suramin in the epithelial cells of the proximal tubular segment

Our investigations, with mice, rats and guinea pigs treated with suramin, furnished evidence that the drug is ingested by reticulo-endothelial cells in which it accumulates, forming granules in the course of a few days. Suramin could also be detected in fibrocytes and serosal epithelial cells. It appears in the course of the first few hours in the epithelial cells of the proximal tubules of the kidney, and may be stored there in large amounts, being visible even after one or two months, inducing occasionally a nephrosis. Thus suramin behaves in the organism similarly to the vital acid dyes (for example, trypan blue) or the

chemotherapeutic arseno-benzene compounds[3]; however, in the elastic tissue of the vascular walls and in the fibrillar structures suramin could not be detected.

Suramin is not present in a free state in the intracellular granules, but in combination with a protein carrier. This view is supported by the fact that, on complete extraction of the dye from the preparation with methyl alcohol, the granules can be stained again. As suramin is very soluble in this solvent, this can only be interpreted by assuming that it is present in a protein linkage, which is in agreement with the fact that methyl alcohol is not capable of splitting off suramin from the protein[4].

In such staining, therefore, suramin plays the part of a mordant, being closely linked to the protein, reacting simultaneously with the basic dye and thus fixing it to the specific granules.

In interpreting the picture demonstrated in the kidney, the close combination between suramin and plasma proteins must be taken into consideration; it makes most unlikely the continuous penetration of the unbound drug through the glomeruli. In our opinion, the histological picture can be interpreted by assuming that a certain amount of protein escapes continuously through the glomeruli and is usually reabsorbed by the tubules. Thus if suramin is present in the plasma, the drug bound to the protein also gains access to the epithelial cells of the tubules and accumulates there. Suramin acts as a tracer showing the physiological path of the protein. We have also completed investigations showing that suramin is introduced into the reticulo-endothelial cells by a similar mechanism, because these cells also ingest proteins from their environment.

Visual Demonstration of Immune Reactions in Tissue

In the preceding communication, microtechnical methods have been reported which enable one to stain Bayer 205 (suramin) in cells so that the fate of the injected drug in the organism can be studied with histological preparations. The great affinity of suramin for proteins and its stability in the organism suggested the use of the drug as a label, thus making possible the demonstration by staining procedures of the further fate of proteins in normal and immune animals. It could be assumed that with suitable experimental conditions the *in vivo* reaction proceeding between the antigen and the antibody will be accessible for direct visual observation. It seemed that for this purpose the elicitation of the Arthus phenomenon with suramin-labelled protein would be the most appropriate.

Rabbits were injected intraperitoneally three times with 1 ml. of horse serum at intervals of two days; the test injection was carried out 5–15 days after the last sensitizing injection. At the test injection the rapid formation of a firm linkage between suramin and the proteins even at physiological *p*H and temperature was taken into consideration. The horse serum was mixed with an equal quantity of physiological saline solution containing 0·5, 0·8 or 1 per cent suramin, and 0·5 ml. was injected intracutaneously or subcutaneously in the dorsal or abdominal region. In animals sacrificed after 48–55 hr., a hæmorrhagic œdematous inflammation developed in an area 5–7 cm. in diameter at the site of the injection, which was absent in the similarly treated non-sensitized controls. Membranes from the subcutaneous connective tissue put on slides were stained with methylene blue eosinate dissolved in methanol in the manner described in our previous paper to demonstrate the suramin deposited in the tissues.

In the controls, the connective tissue is in a resting state exhibiting multipolar or spindle-shaped histiocytes with but few cytoplasmic granules containing suramin, and some round cells of monocyte character with a few specific granules. Undoubtedly the suramin was almost entirely resorbed together with the foreign protein from the local depot. In sensitized animals, on the contrary, it was retained in large quantities in the inflamed area and could be detected as accumulations in different types of cells. Not only the histiocytes, but also the capillary endothelial cells—the connexion of which was interrupted here and there—were crowded with granules containing suramin, and even the fibrocytes contained granules. However, the whole picture was dominated by the presence of numerous macrophages loaded with dark-coloured granules (Figs. 1 and 2).

The considerable storage observed at the site of the Arthus reaction cannot be ascribed to the enhanced capacity for phagocytosis of the cells of the animals pretreated with protein, since on injecting human serum mixed with suramin into rabbits sensitized with horse serum, this phenomenon could not be observed. The characteristic picture must therefore be due to specific serological causes. Local anaphylaxis is generally attributed to the combination of the antigen and the precipitin—mainly to circulating precipitin (cf. ref. 5)—occurring in the tissues. Hence we believe the explanation of the considerable storage of suramin is that these cells ingest the resulting antigen–antibody complexes and, with the large amount of protein, the bound suramin too.

Hitherto there has been inadequate explanation of the vigorous and specific inflammatory stimulus caused by protein injected into the tissues of the sensitized organism. We think that the characteristic

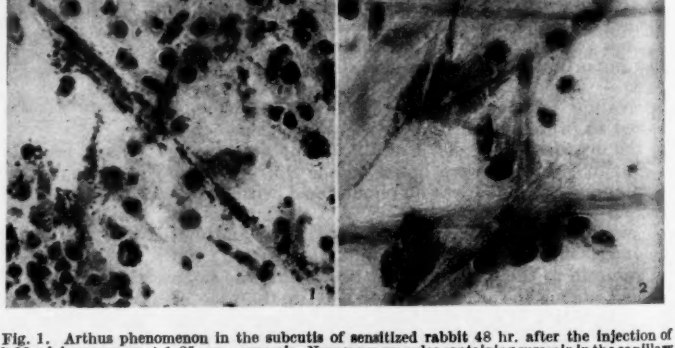


Fig. 1. Arthus phenomenon in the subcutis of sensitized rabbit 48 hr. after the injection of 0·25 ml. horse serum + 1·25 mgm. suramin. Numerous granules containing suramin in the capillary endothelium and in the macrophages

Fig. 2. Control experiment, non-sensitized animal. In the body of resting histiocytes there are only a few granules containing suramin

histological picture of the Arthus phenomenon becomes much clearer by the actual demonstration that many cells of various types, including capillary endothelial cells, become heavily loaded with large masses of foreign and their own proteins.

It is a fundamental serological observation that foreign serum proteins and antibodies are eliminated at an accelerated rate from the blood stream as soon as the incubation period of immune body production ends; they persist only a very short time after sensitization in the circulating blood, and in the case of the subcutaneous application they become fixed locally. Undoubtedly the phenomenon described above plays a decisive part in local fixation. However, investigations in progress suggest that in general the rapid elimination of foreign proteins is due to the fact that the cells of the reticulo-endothelial system promptly ingest the antigen-antibody complexes owing to their colloid chemical properties.

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THE DE HAAS–VAN ALPHEN EFFECT AT HIGH FIELDS

By Dr. D. SHOENBERG
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RECENT experiments[1] have shown that the dependence of susceptibility on the periodic field originally discovered in bismuth by de Haas and van Alphen occurs also in many other metals at temperatures in the liquid helium range and magnetic fields up to about 15,000 gauss, such as are available in an ordinary electromagnet. According to the theory, however, the effect is detectable at such low fields only because of the anomalous values of the electronic parameters (effective masses and effective degeneracy parameter) characteristic of the complicated form of the Fermi surface in the metals concerned. For an ideal 'free electron gas' metal, the amplitude of the susceptibility oscillations should become appreciable only at much higher fields—of order 10^6 gauss; and the period should then be very small—of order 50 gauss or so. This is in agreement with the fact that no effect has yet been found by conventional techniques in metals such as gold, silver and copper. Experiments at higher fields are therefore of interest not only because they offer the possibility of discovering the effect in other metals and studying it in conditions where the theory can be tested most directly, but also because it would be of interest to study the effect at higher fields in metals for which it has already been found at lower fields. Comparison with theory suggests that in such metals only a very small proportion of the conduction electrons contribute to the effect at low fields, and it might be expected that short-period oscillations corresponding to the remainder of the electrons would occur at higher fields.

The usual method of studying the de Haas – van Alphen effect is to measure the torque on a single crystal suspended in a uniform magnetic field, but considerable difficulties are involved in extending this method to much higher fields. Such fields are most easily available in large water-cooled solenoids; but the geometry of such solenoids would make measurement of the torque awkward, and moreover it would be difficult to hold the field sufficiently stable—to 1 part in 10^4 or 10^5—to avoid smearing out oscillations of short period. It was therefore decided to try an entirely different technique of the type used by Kapitza, in which the high field is produced only momentarily, and to observe the oscillations of susceptibility by electromagnetic induction rather than by a mechanical method. The advantage of an induction method is that it measures the differential susceptibility $\mathrm{d}I/\mathrm{d}H$ rather than I/H, and if I/H oscillates rapidly with H the amplitude of $\mathrm{d}I/\mathrm{d}H$ may become large even though the amplitude of I/H is only of order 10^{-5}, since $|\,\mathrm{d}I/\mathrm{d}H\,| = \frac{2\pi H}{h}|\,I/H\,|$, where h is the period of the oscillations. With the development of cheap high-capacity condensers, it is a simple matter to produce fields of order 10^5 gauss in a fairly small coil, designed so that the field should be uniform to 1 part in 10^4 or 10^5 over the length of a short specimen (~ 5 mm.).

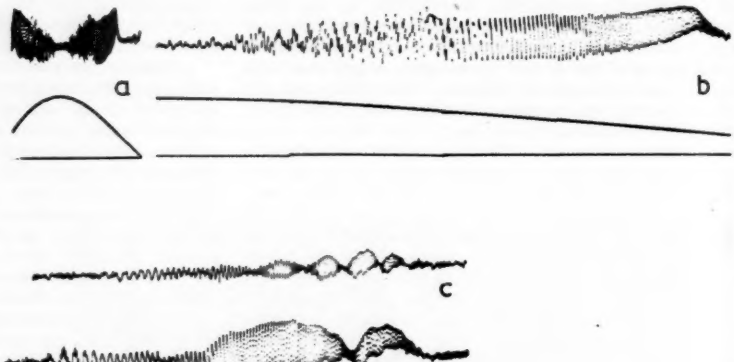
In the actual arrangement used, a condenser of capacity 1,000 μF. is discharged through a liquid-air cooled coil 12 cm. long, of external diameter 2·9 cm. and with an internal hole 0·8 cm. diameter, wound with 1,670 turns of 22 S.W.G. copper wire. When the condenser is charged to 1,750 volts, discharge produces a field rising to a maximum of $0{\cdot}9 \times 10^5$ gauss in about 3 m.sec., which then falls off to zero rather more slowly (the circuit is approximately critically damped). The solenoid fits closely around a Dewar vessel inside which are two 'pick-up' coils, each 1 cm. long and each wound with about 1,450 turns of 47 S.W.G. copper wire, connected in opposition so that the E.M.F. induced in the empty coils by the changing field is roughly zero. The specimen is placed in the region of uniform field of the solenoid at the centre of one of these coils, so that, if its magnetization varies, an E.M.F. proportional to $\mathrm{d}I/\mathrm{d}t$, and therefore to $\mathrm{d}I/\mathrm{d}H$ and $\mathrm{d}H/\mathrm{d}t$, is produced across the coils. This E.M.F. is amplified about 10^5 times and displayed on a cathode-ray oscilloscope triggered to give a single sweep when the discharge takes place. The exact moment of triggering and the duration of the single sweep can be varied so that any part of the curve can be examined in detail; the other beam of the cathode-ray oscilloscope is used to display the time variation of the solenoid current, that is, the field variation, and the picture is recorded photographically.

In order to try out the method and to develop the technique, the first experiments were made with tin, in which the de Haas – van Alphen effect has already been studied at low fields; using a single crystal with its tetragonal axis at about 70° to the field, the oscillations were successfully observed. Fig. *a* shows the oscillograph record at 1·2° K., using a sweep-time of about 10 m.sec. with a triggering delay time of about 1·5 m.sec.; the oscillations are unresolved and only the envelope can be seen as a kind of 'butterfly' pattern. As already mentioned, the observed amplitude is proportional to $\mathrm{d}H/\mathrm{d}t$ as well as to $\mathrm{d}I/\mathrm{d}H$, and so vanishes at the maximum of H. Fig. *b* is a composite picture of 1-m.sec. sweeps with various delays showing the oscillations in the right-hand half of the 'butterfly' resolved; the

apparent frequency varies because equal intervals of H do not correspond to equal intervals of time, and also because the periodicity is uniform in $1/H$ rather than H. Analysis of the curves shows that the main period in $1/H$ is $2{\cdot}2 \times 10^{-7}$ gauss^{-1}; according to the theory, this period gives β/E_0, where β is an effective double Bohr magneton (that is, $e\hbar/mc$, where m is an effective electron mass) and E_0 is the degeneracy parameter. From the temperature variation of the amplitude, β is found to be $6{\cdot}5 \times 10^{-20}$ (that is, $m = 0{\cdot}28\ m_0$, where m_0 is the true electronic mass), so that $E_0 = 3 \times 10^{-13}$ erg (that is, T_0, the degeneracy temperature, is 2,200° K.). These values are in good accord with the results found from the low-field experiments, where it may be noted that the oscillations were at the limit of resolution of the torque method. It can be seen also that, superimposed on the main oscillations, there are other oscillations of about 4·5 times shorter period. It is probable that these arise from electrons which do not contribute to the effect at lower fields, but no detailed study of these higher-frequency oscillations has yet been made.

A serious difficulty in the general application of the method is the induction of eddy currents in the specimen by the varying magnetic field. These eddy currents can mask the effect in two ways. First, they cause the field in the interior of the specimen to lag behind that at its surface, and if the lag is too great the resulting non-uniformity of the field will smear out the oscillations; and secondly, the eddy currents may raise the temperature of the specimen sufficiently to reduce the amplitude of the de Haas – van Alphen effect. Both eddy current effects can be reduced by using specimens of small diameter, and are further reduced by the increase of resistance in a high magnetic field (fortunately, for many metals this increase is considerable at low temperatures). For oscillations with the relatively large period shown by the tin specimen, the 'smearing' effect due to non-uniformity is not serious except perhaps at fairly low fields, where dH/dt is large and the period in H is small. The seriousness of the rise of temperature was, however, clearly demonstrated by an experiment in which the tin crystal was contained in a glass envelope, and it was found that the amplitude was considerably reduced—presumably due to the poorer thermal contact with the bath. It is probable that the relaxation time for heat transfer is short compared with 1 m.sec., so that the instantaneous rise of temperature should be proportional to $(dH/dt)^2$, and the reduction of amplitude was indeed most marked where dH/dt was large. With the tin directly in contact with liquid helium, the heat transfer appeared to be adequate to prevent any serious rise of temperature. These considerations suggest that for really high-frequency oscillations—such as are to be expected for a metal such as gold—it will be possible to observe the oscillations only very close to the maximum of H, that is, where dH/dt is sufficiently small. The position is made more difficult also by the fact that in such metals as gold the increase of resistance with magnetic field is not nearly as great as with tin, so that the eddy current effects should be much greater. In fact, in one trial experiment with a gold crystal, no oscillations greater than the background noise were observed, and it is clear that the technique will have to be refined before it will work for metals approaching the ideal free-electron model.

So far, the only success of the method, other than indicating new high-frequency oscillations in tin, is the discovery of the de Haas – van Alphen effect in lead, for which no effect could be found at low fields by the torque method. The results for two single crystals are illustrated in Figs. *c* and *d*, and it can be seen that the period is appreciably shorter than for the tin specimen. The 'beats' in the oscillations, which are similar to those found in other metals at low fields, are presumably due to the presence of several nearly equal frequencies. Rough extrapolation to low fields makes it plausible that the amplitude of the oscillations in lead would indeed have been too small to observe at 15,000 gauss by the torque method, and even at somewhat higher fields the period would have been too short to resolve. Analysis shows that β/E_0 is $3{\cdot}9 \times 10^{-8}$ gauss^{-1} for crystal *A* with H at 20°, 73°, 81° to the cubic axes and $4{\cdot}5 \times 10^{-8}$ gauss^{-1} for crystal *B* with H at 52°, 54°, 58° to the cubic axes; a third crystal, *C*, with H at 47°, 48°, 72° to the cubic axes, gave $\beta/E_0 = 4{\cdot}6 \times 10^{-8}$ gauss^{-1}, so it seems that β/E_0 is not very sensitive to the direction of H relative to the crystal axes. From the tempera-



(*a*) Tin: 'butterfly' pattern showing the oscillations unresolved, 1·2° K.; peak field, $7{\cdot}0 \times 10^4$ gauss.
(*b*) Same as right-hand half of *a* but on expanded time-scale.
(*c*) Lead *A*, 1·2° K.; peak field, $8{\cdot}2 \times 10^4$ gauss, on expanded time-scale, as in *b*.
(*d*) Lead *B*, 1·2° K.; peak field $8{\cdot}2 \times 10^4$ gauss, on expanded time-scale, as in *b*.

The lower curves in *a*, *b* and *d* show the variation of the solenoid current measured from the horizontal base-line; *c* is arranged so that the same current curve applies as for *d*. In all the curves the time increases from left to right: *a* is 7 m.sec. long, *b* 3 m.sec., and *c* and *d* 2·4 m.sec. The slight ripples on the current curves are caused by a slight coupling between the two beams of the cathode-ray oscilloscope; the 'dot' pattern superimposed on the oscillations is due to a high-frequency modulation in the beam strength of the cathode-ray oscilloscope

ture variation of the amplitude, rough estimates of β could be made for the three crystals, from which it was found that E_0 was about 8×10^{-13} erg (that is, T_0, the degeneracy temperature, was about 6,000° K.); the value of m/m_0 for crystal *A* was about 0·5. For crystal *C*, oscillations of roughly five times shorter period were visible near the maximum of H; it is interesting that this short period ($\beta/E_0 \sim 10^{-8}$ gauss^{-1}) approaches the order of magnitude to be expected for one free electron of normal mass per atom ($\beta/E_0 = 0{\cdot}3 \times 10^{-8}$ gauss^{-1}). The conditions for showing up these very short-period oscillations seem to be rather critical, and their behaviour has not yet been studied in detail. The very short period oscillations visible at the left in Fig. *d* are probably not due to the de Haas – van Alphen effect, but to some stray effect, since they appear to be of constant period in time rather than in $1/H$.

These preliminary experiments suggest that the method will be useful in giving new information about the electronic structure of metals, and it is planned to extend the work both to study in greater detail the characteristics of the de Haas – van Alphen effect at high fields in metals for which it is known to occur at low fields, and to look for the effect in other metals. The initiative in developing the condenser discharge method of producing high magnetic fields came from Mr. E. Laurmann before its application to the present problem suggested itself, and I owe him a great debt of gratitude for his success in making it work and for his assistance throughout these experiments. My thanks are due also to Dr. R. G. Chambers and Dr. D. V. Osborne for their valuable collaboration in designing and in part constructing the necessary electronic apparatus, without which the experiments could not have been carried out.

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LUMINESCENCE OF AQUEOUS SOLUTIONS OF RADIOACTIVE ISOTOPES AND THE ČERENKOV EFFECT

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In studies of liquid luminescent systems for use in scintillation counters, Mayneord and Belcher[1] observed a luminescence of low order in aqueous solutions of radioactive isotopes. Such an effect might be attributed to excitation of the substrate[2] or to the Čerenkov effect[3,4]. In view of the significance of these phenomena in the fields of radiation chemistry and biology, a quantitative study of the intensities of emission induced by beta-emitters of various energies has been made.

The emission intensities were measured with a 1-*P*-21 photomultiplier tube cooled with liquid nitrogen coupled to a linear amplifier (type 1008) and counting-rate meter (type 1037*A*). The radioactive solutions were contained in small cylindrical cells of 'Perspex', and of 'Dural' in which a 'Perspex' window formed one basal plane. The cells had a capacity of 6·25 ml. and were optically coupled to the photomultiplier by a short light guide. Quartz cells were at first used but proved unsatisfactory owing to fluorescence excited in the cell walls.

Experimental results for a number of beta- and beta–gamma emitting isotopes are tabulated below. For these studies, the amplifier was set at its maximum gain of 16,000, and the ratemeter discriminator at its minimum setting of 5 volts. The radioactive concentrations studied were chosen so that the counting-rates lay initially between 100 and 200 counts/second, but the rates shown in the table have been fully corrected for the small background effects and referred to a concentration of 1 μC./ml. With two exceptions, the activities of the solutions were measured in sub-standard liquid Geiger–Müller counters[5], themselves calibrated in terms of carbon ionization chamber gamma-measurements and defined solid angle beta-counting[6]. The exceptions were the low-energy beta-emitters calcium-45 and sulphur-35, which were standardized directly by defined solid-angle methods.

Studies of the amplitude distribution of the pulses at the input to the ratemeter indicated that they corresponded to the emission of single electrons at the photomultiplier cathode. It is thus permissible to treat the observed counting-rates as measures of the intensities of emission in the spectral range of the photomultiplier.

The classical theory of Frank and Tamm[7] implies a low energy limit for the Čerenkov effect satisfying the relationship $\beta = 1/n$, where β is the velocity of the emitting particles relative to that of light and n the refractive index of the medium. For electrons, this limit corresponds to 0·260 MeV. in water and 0·177 MeV. in 'Perspex'. The luminescence observed in solutions containing sulphur-35 and calcium-45 can thus be ascribed entirely to excitation processes in the substrate.

To a first approximation luminescent effects due to such processes may be assumed proportional to absorbed energy and thus, ignoring effects due to self-absorbed gamma-radiation and to the escape of electrons through the cell walls, to mean beta-particle energy. The expected contribution of excitation processes to the observed emission in the case of the higher-energy emitters studied can thus be estimated from the observed intensities for sulphur-35 and calcium-45. This contribution is found to represent only a small fraction (< 2 per cent) of the observed total intensities. The residuum after the estimated excitation intensity has been subtracted may be attributed to the Čerenkov effect.

Frank and Tamm's theory gives the following expression for the number dN of photons with wavelengths lying between λ_1 and λ_2 emitted in a length dl of track:

$$dN = 2\pi\alpha \left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)\left(1 - \frac{1}{\beta^2 n^2}\right) dl, \qquad (1)$$

where $\alpha = \dfrac{2\pi e^2}{hc}$. Hence, the total number N_E of photons within these limits emitted along the track of a particle of initial energy E brought to rest within the medium is given by

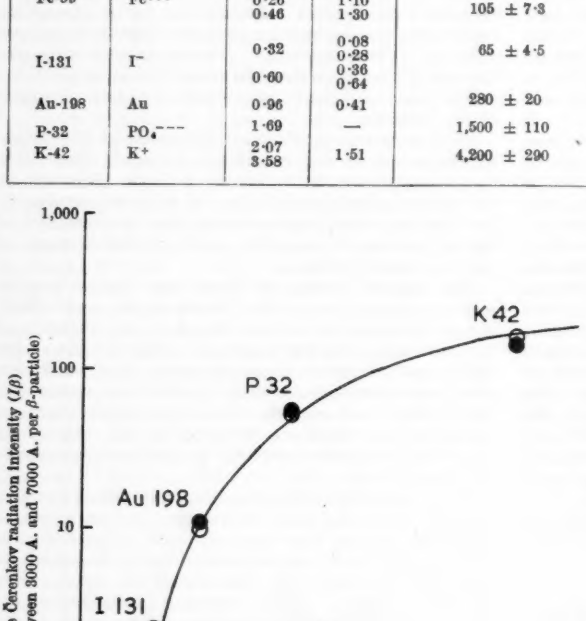
$$N_E = 2\pi\alpha \left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right) \int_{\beta n > 1} \left(1 - \frac{1}{\beta^2 n^2}\right) dl. \qquad (2)$$

For the spectral range of the photomultiplier ($\lambda_1 = 7000$ A., $\lambda_2 = 3000$ A.) equation (2) reduces to

$$N_E = 874 \int_{\beta n > 1} \left(1 - \frac{1}{\beta^2 n^2}\right) dl. \qquad (3)$$

Experimental Results for Beta- and Beta–Gamma Emitting Nuclear Species in Aqueous Solution

Nuclear species	Chemical form	Radiations		Observed counting-rate for 1 μC./ml. (corrected for background effects)		Remarks
		β (MeV.) max.	γ (MeV.)	'Perspex' cell counts/second	'Dural' cell counts/second	
S-35	SO_4^{--}	0·168	—	0·25 ± 0·017	0·25 ± 0·017	
Ca-45	Ca^{++}	0·254	—	0·55 ± 0·038	0·55 ± 0·038	
Co-60	Co^{++}	0·31	1·17 1·33	160 ± 10·6	85 ± 5·9	
Fe-59	Fe^{+++}	0·26 0·46	1·10 1·30	105 ± 7·3	72 ± 5·0	
I-131	I^-	0·32 0·60	0·08 0·28 0·36 0·64	65 ± 4·5	64 ± 4·5	
Au-198	Au	0·96	0·41	280 ± 20	280 ± 20	Gelatine stabilized sol.
P-32	PO_4^{---}	1·69	—	1,500 ± 110	1,440 ± 100	
K-42	K^+	2·07 3·58	1·51	4,200 ± 290	3,100 ± 210	



Exp. values: ⊙, 'Perspex' cell; ●, 'Dural' cell

This integral can be evaluated graphically from a knowledge of the range–energy function for electrons in the medium. In the case of a beta-emitting radioisotope, the energy distribution of the emitted beta-particles must be taken into account. If P_E is the probability of release of a beta-particle with energy between the limits E and $(E + dE)$, then the average total intensity $I\beta$ of Čerenkov emission per beta-particle is given by

$$I\beta = \int_0^{E_{max.}} P_E \,.\, N_E \,.\, dE. \qquad (4)$$

In the accompanying figure, the relative values of the observed intensities, corrected as described above for excitation effects and also for escape of electrons from the medium, for self-absorbed gamma radiation, and for Čerenkov emission in the 'Perspex' walls, are compared with the theoretical intensities per beta-particle obtained from equation (4), the intensities being plotted against maximum beta-particle energy. The corrections were small except in the case of the energetic gamma-emitters iron-59 and cobalt-60. The observed relative intensities have been superimposed on the calculated intensity–energy function so that exact agreement is obtained for gold-198 solutions in 'Perspex' cells. The relative values for the other nuclear species studied show good agreement with Frank and Tamm's theory, though there is some evidence of a systematic deviation at energies near the threshold. Similar deviations have been reported by Wyckoff and Henderson[8] for the angular distribution of emission induced by mono-energetic electrons in mica films.

Equation (3) predicts the release of some 90 photons between 3000 A. and 7000 A. by a single 1-MeV. electron brought to rest in an aqueous medium. The observed intensities were in general agreement with this value, although uncertainties in the detection efficiency of the measuring system did not permit its accurate confirmation. A more detailed account of this work will be published at a later date.

I wish to record my indebtedness to Prof. W. V. Mayneord, director of the Physics Department, for his interest and encouragement throughout these studies. Acknowledgment is also due to the Medical Research Council which supported the investigation.

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LETTERS TO THE EDITORS

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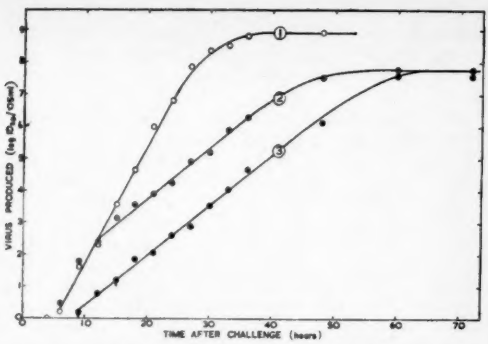
Multiplication of Influenza Virus under Conditions of Interference

ALTHOUGH it is well established that inactivated viral particles interfere with the multiplication of active virus, the intimate mechanism of the phenomenon is unknown. The fundamental experiments, confined to the comparison of final yields, did not show whether the observed depression resulted from complete incapacitation of some cells, from an overall lowering of cellular output, or merely from the slowing-down of the process. Similarly, it is not clear whether the challenging inoculum enters all cells at random, or only those which have the potential ability to yield virus. Some of these questions have been answered by the kinetic study of interference, and the results will be reported in full elsewhere; here we propose to point out some peculiarities of the growth curves, as they reveal possible pitfalls in the planning and interpretation of interference experiments.

Heat-inactivated *LEE* (influenza *B*) virus was used as interfering agent in 0·5-ml. volumes injected allantoically into eleven-day eggs. The challenging dose, 100 ID_{50} of *MEL* (influenza *A*) virus, followed after 45 min.; in later experiments, for reasons set out below, a second group was included with 24 hr. between the two inoculations. The group of control eggs received only the challenging inoculum of *MEL* virus. At intervals, 0·05-ml. samples of allantoic fluid were withdrawn and titrated for infectivity.

The group of controls (curve 1) behaved as would be expected from earlier reports in the literature[1]; the titre rose at a steady logarithmic rate between the sixth and twenty-seventh hour, and then levelled out at a maximum of $10^{10\cdot20}$ ID_{50} per ml. Curve 2 (the group challenged 45 min. after administration of the interfering inoculum) is remarkable for the change in slope after the fourteenth hour. This means that, in spite of the interfering dose, the first cycle of multiplication was in every respect the same as in normal eggs, that is, either interference had not yet been established or, if so, the challenging inoculum multiplied only in cells not affected. To clear up this point, the interval between the administration of interfering and challenging doses was increased to 24 hr. (curve 3). This curve has a uniform slope (1·43), the same as that of curve 2 from the fifteenth hour onwards (1·45), and also reaches the same maximum ($10^{9\cdot05}$ ID_{50}/ml.), though 12 hr. later. The difference between curves 2 and 3 suggests that the establishment of interference—as opposed to the adsorption of virus[2]—is not instantaneous; and in the special case when active virus closely follows inactive, the high final yield after large challenging inocula which could exhaust all available cells within two cycles of multiplication might appear as the 'overcoming of interference'[3], though, in fact, it is but the 'by-passing of interference'. With an appropriate interval between the two inoculations, the final yield is independent of the challenge dose[2,4].

Comparison of curves 1 and 3 shows that a lower slope is as characteristic of the growth-curve during interference as is the lower final yield. By failing to reckon with this (that is, if experiments are terminated as is usual after 48 hr.) an exaggerated picture might be obtained, as smaller challenging inocula might not have reached maximum titres at the time of harvesting. It is interesting to note that a log 1·15 reduction of yield goes with a log 0·205 reduction of slope, and from this the average length of the multiplication cycle works out as 1·15/0·205 = 5·6 hr. Though this is considerably lower than the value given in the literature (release of virus starting at 6 hr. and not completed before 10 hr.), it seems significant that the hitherto available estimates of burst size and length of cycle are incompatible with the observed growth-curves[1], while the above value fits them all.



Curve 1: 100 ID_{50} of active *MEL* (*A*) virus; curve 2: 400 agglutinating doses of heated *LEE* (*B*) virus followed after 45 min. by 100 ID_{50} of active *MEL* (*A*) virus; curve 3: 400 agglutinating doses of heated *LEE* (*B*) virus followed after 24 hr. by 100 ID_{50} of active *MEL* (*A*) virus. Infectivity titrations were done in 3·16- or 10-fold steps, using 5–10 eggs per dilution. The points of curves 1 and 2 are the geometric means of four, those of curve 3 of three, replicate experiments

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Macrophages in the Periodontal Tissues of Rats' Incisor Teeth

IN a previous communication[1], it was reported that the incisor teeth of rats kept on a poor South African diet developed signs of deficiency of vitamin A and of calcium. In addition, the sub-enamel tissues contained a large number of macrophages laden with highly refractile orange-coloured granules, as has also

been described in vitamin E deficiency by Granados, Mason and Dam[2]. The present communication records investigations of the granular ameloblasts and macrophages of normal and experimental rats' upper incisor teeth.

The material examined was from normal rats and those with acute or healing rickets or suffering from deficiency of vitamin A or E. Preparations of enamel organs were dissected from teeth which had been fixed in formol-saline but not decalcified. These were mounted as smears or frozen sections. In addition, central longitudinal sections of ground or decalcified tissues were examined. The ground sections were impregnated with acrylic after bulk staining with alcoholic borax-carmine and were ground to a thickness of about 15 μ, using the technique already described[3]. With such thin sections, histological details were well seen. The decalcified sections were treated, after fixation, with 5 per cent nitric acid in formol-saline for about five days, and were afterwards processed in the usual way.

It was found that decalcification of the tissues often altered the appearance and histochemistry of the granules in an unpredictable way, so the decalcified sections were chiefly used for studying the cytology and situation of the macrophages.

Refractile orange granules were found in the granular ameloblasts and also in macrophages situated under the enamel organ of undecalcified preparations. The granular ameloblasts are found just behind the area where pigment is first deposited on the enamel[4]. The granules in both situations had the same histochemical properties. They did not stain with hæmatoxylin and eosin, basic fuchsin or osmic acid; they were not acid-fast, did not fluoresce in ultra-violet light nor were they doubly refractile. They stained intensely for iron and also with ammoniacal silver. In sections where the pigmented enamel had remained in strips, this structure gave the same reactions. The various experimental procedures did not alter these reactions of the granules and pigmented enamel, except that the iron reaction was greatly reduced or absent in the later stages of vitamin E deficiency. From the above evidence it would appear that the granular material in the ameloblasts and macrophages and the pigment of the enamel were identical or very similar chemically. Stein and Boyle[5] considered the pigmented enamel layer to be a melanin, while Dam and Granados[6] stated that it was not a lipochrome, porphyrin or melanin.

After decalcification with nitric acid, the character of the granules sometimes changed; those in the ameloblasts might disappear, while those in the macrophages might lose their refractile appearance and positive iron reaction, stain grey with hæmatoxylin and intensely with basic fuchsin. Ground sections made from the corresponding opposite tooth invariably showed orange refractile granules in both types of cells.

Macrophages were only found where the enamel organ had normally retrogressed, in the incisal quarter of the tooth, or where it had atrophied prematurely owing to the experimental procedures used. They appeared to originate from fibrocytes in contact with the enamel. These spindle-shaped cells contained small amounts of refractile material which seemed to come from the pigmented layer of the enamel. As they receded from the enamel, these cells grew in size until they became large oval cells with a deeply stained round, oval or indented nucleus. The refractile material in their cytoplasm coalesced by a process of coacervation into large granules.

In normal teeth a few rows of macrophages were found in the sub-enamel organ tissue between the crest of the labial alveolar bone and the gingival margin. In experimental conditions, when the enamel organ had retrogressed prematurely or atrophied, macrophages were found much farther back, lying under the area of atrophy, while in vitamin A-, and especially vitamin E-, deficiency, when almost the entire enamel organ was atrophied[7], a great number of them would be found under the atrophied organ. It was noted in several teeth dissected from vitamin E-deficient animals that, whereas the enamel was almost entirely white, an area of pigmentation was to be seen at the extreme formative end. The same was seen in ground sections.

It appears from the above observations that the macrophages or their precursors remove the pigment, in part or wholly, from the enamel when it is not covered with functional ameloblasts. In vitamin A- and E-deficiency, so much of the enamel organ has atrophied that the whole of the pigment may be removed. In the vitamin E-deficient animals studied, which had been on the diet about sixty days, the granules in the ameloblasts and those in the macrophages still contained iron. Possibly at a later stage these granules became iron-free, as would be suggested by the work of Dam and Granados[6,8]. It is very unlikely that the macrophage pigment in vitamin E-deficiency is ceroid, as has been suggested by Dam, Granados and Maltesen[8].

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Localization of Erythemal Processes caused by Ultra-Violet Light in Human Skin

Since the fundamental experiments of Hausser and Vahle[1], in 1922, it has been known that two wavelength regions of the ultra-violet spectrum, namely, near 297 mμ and about 250 mμ, have maximum efficiency in producing erythema in human skin. These regions are separated by a region near 280 mμ with small erythemal activity. The explanation for this action spectrum has been sought in the screening function of the superficially situated horny layer which, as a protein with aromatic compounds, has a maximum light absorption[2] near 280 mμ.

Radiation experiments with a quartz spectrograph and the interpretation of the results of reflexion

measurements of human skin with monochromatic ultra-violet and visible light led one of us to the conclusion that the two active wave-length regions represent two independent photochemical reactions. Moreover, the reaction at 250 mμ should be localized in the most superficial layers of the epidermis—the horny, clear or granulous layers—whereas the reaction at 297 mμ should be localized in the mucous layer[2].

The following experiment gave almost conclusive evidence for this deduction. Transparent adhesive plastic tape applied to the skin of the forearm for 10 min. removes two or three layers of horny cells when torn away. By repeating this procedure nine to a dozen times the whole stratum corneum is taken away without interfering with the stratum granulosum or lucidum, since the adhesive tape does not hold on these moist layers (E. H. Graul, private communication).

For one of us, the minimum doses for erythema have been determined as accurately as possible for the normal skin of the forearm, for the two wave-length regions mentioned. Afterwards, this dose was radiated on to the normal skin of the forearm and on to an adjacent part of the skin where the horny layer had been torn away. The reactions on both skin parts are indicated in the accompanying table.

Erythemal Reaction of Skin

Time elapsed since moment of irradiation (hr.)	Normal skin		Skin without horny layer	
	± 300 mμ	250–260 mμ	± 300 mμ	250–260 mμ
4	−	−	±	−
6	−	−	+	−
7	−	±	++	−
8	±	±	++	±
9	±	±	++	−
10	±	+	++	−
11	+	++	++	±
12	+	+	++	±
13	±	+	++	−
14	±	+	++	−
15	±	+	++	−
22	−	±	++	−
45	−	−	++	−

−, No erythema perceptible; ±, erythema uncertain; +, distinct erythema; ++, strong erythema.

The erythemal reaction at 300 mμ was much stronger on the skin without horny layer than on the normal skin, apparently because the heavier dose of irradiation penetrates into the mucous layer where the screening effect of the horny layer is absent. Also the absence of the scattering effect of the horny layer, which causes a broader spot of the mucous layer to be irradiated in normal skin, should be taken into consideration. First, it makes the skin without horny layer receive the full irradiation dose on a smaller area; secondly, it makes the erythema more distinct.

The erythemal reaction after irradiation with light of wave-length 250–260 mμ was practically absent on skin without the horny layer. As the absorption and especially the scattering effects are much stronger at the shorter wave-length, a much stronger reaction would have been expected after irradiation with these wave-lengths than after irradiation with 300 mμ, if the primary photochemical reaction be localized in the mucous layer as is the case with the 300-mμ reaction. Therefore, the absence of the erythemal reaction on the skin without horny layer leads to the conclusion that the primary photochemical reaction at 250–260 mμ is localized in the horny layer.

In accordance with what is known from the formation of vitamin D by ultra-violet light from sterols in the upper layers of the skin and hairs, we suggest that photolysable substances in the stratum corneum are responsible for the erythemal reaction with ultra-violet light of the wave-length 250–260 mμ. These substances might even be sterols.

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Synthesis of Deoxyribose in Animal Tissues

Possible routes for the synthesis of ribose and deoxyribose may be either by degradation of a higher carbon compound, such as a hexose, or by condensation of two lower carbon compounds, for example, a triose combining with a compound containing two carbon atoms. As regards the first possibility, Dickens[1], Cohen and Scott[2], and Horecker, Smyrniotis and Seegmiller[3] have produced evidence that ribose-5-phosphate is an intermediary in the direct oxidation of glucose-6-phosphate by enzymes present in yeast, and more recently similar results have been obtained using extracts of animal tissues[4]. It is uncertain as yet to what extent this pathway is responsible for the synthesis of pentoses in tissues, and there is little evidence to suggest that it is applicable to deoxyribose. Evidence for the second possibility—the condensation of a triose with a two-carbon compound—has been produced by Racker[5], who demonstrated that bacterial extracts formed deoxyribose phosphate in the presence of glyceraldehyde phosphate and acetaldehyde.

We have now obtained evidence that a similar reaction can occur in animal tissues. In our experiments, fructose-1-6-diphosphate (as a source of triose) and acetaldehyde were incubated with an extract of guinea-pig liver in the presence of iodoacetic acid. The extract was obtained by homogenizing the fresh liver with Ringer phosphate, centrifuging and taking the supernatant fluid. After the addition of barium acetate and alcohol to the incubated mixture, the precipitate was removed by centrifuging and the supernatant solution, with barium removed, was evaporated to dryness under reduced pressure, and prepared for paper chromatography by pyridine extraction[6]. The chromatograms, when run in *iso*butyric acid or in collidine, and developed by the method of Bryson and Mitchell[7], showed the presence of deoxyribose. Control experiments, in which the liver extract was incubated either alone, or with fructose diphosphate or acetaldehyde separately, gave no deoxyribose.

In further experiments the chromatographic paper was cut off from undeveloped chromatograms at the deoxyribose level and eluted with cold phosphate buffer (*p*H 7·4). After evaporation of the solution to dryness *in vacuo* and extraction with pyridine as before, positive Dische[8] and Stumpf[9] reactions for deoxyribose were obtained. The controls cut off at the same level were negative.

The barium precipitate centrifuged from the original mixture also gave chromatographic evidence of deoxyribose after removing the barium and submitting the solution to the action of alkaline phosphatase. This suggests that the free deoxyribose found in the supernatant from the barium alcohol precipitation is derived from a phosphate ester.

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Methane Fermentation in the Rumen of Cattle

The production of methane in the fore-stomachs of ruminants is of much importance, considering the fact that a cow produces about 500 l. of methane daily[1], which comprises about 10 per cent of the energy value of the digestible nutrients in the feed consumed.

Rumen gas consists of about 70 per cent carbon dioxide and 30 per cent methane[2]. Oxygen is practically absent; as soon as it enters the rumen it will be immediately consumed by the rumen flora. Hydrogen is absent or present only in very small amounts; by feeding large amounts of oatmeal mixed with water, however, the percentage of hydrogen in the gas may be raised considerably[3].

So far, the methane fermentation has been intensively studied on pure substances or with sewage sludge as substrates. Methane bacteria are able to utilize, among other substances, lower fatty acids, alcohols, and succinic acid, which, by being oxidized, enable the bacteria to reduce carbon dioxide to methane. A few species are able to reduce carbon dioxide by hydrogen gas. It is not known which compound acts as a substrate for the methane fermentation in the fore-stomachs of ruminants. Fatty acids, mainly acetic and propionic, are produced in the rumen in significant amounts by cellulose-splitting organisms[4,5]. So these acids might be fermented to methane. According to Hungate[6] and Kaars Sijpesteijn[7] formic acid is also produced by cellulose-splitting rumen bacteria. The absence of hydrogen in the rumen gases might be explained by its immediate conversion into methane by methane bacteria—a theory put forward by Hungate and others[8].

In our experiments on methane production in rumen fluids we made use of a goat with a rumen fistula. We succeeded in isolating a methanosarcina which ferments acetic acid to methane and carbon dioxide. It proved to be an easy task also to produce a culture of a methanobacterium using hydrogen gas for this reduction, as was also done by Julia Schmitz in Hungate's laboratory[6]. These experiments, however, although proving that methane bacteria are abundant in the rumen, offered no solution to the question which compound really acts as a substrate.

Table 1

	CO_2 (ml.)	H_2 (ml.)	CH_4 (ml.)	Total (ml.)
Sodium acetate, after 5½ hr. at 40° C.				
Plus acetate	13·0	0·6	11·1	24·7
Blank	16·6	0·8	13·1	30·5
Difference	−3·6	−0·2	−2·0	−5·8
Calcium propionate, after 5½ hr. at 40° C.				
Plus propionate	15·3	0·3	7·6	23·2
Blank	16·3	0·5	9·0	25·8
Difference	−1·0	−0·2	−1·4	−2·6
Sodium butyrate, after 6½ hr. at 40° C.				
Plus butyrate	9·2	0·1	6·2	15·5
Blank	10·8	0·0	7·2	18·0
Difference	−1·6	+0·1	−1·0	−2·5
Sodium succinate, after 5½ hr. at 40° C.				
Plus succinate	24·0	1·1	13·7	38·8
Blank	6·8	0·7	7·1	14·6
Difference	+17·2	+0·4	+6·6	+24·2

In order to collect information on this point other experiments were set up as follows. About 1 per cent of the compound to be investigated was added to the contents of a flask completely filled with rumen fluid. After placing the flask for 4–6 hr. in a water-bath at 40° C. the gas produced was analysed and compared with the gas evolved by a blank containing only rumen fluid without substrate added.

The results are shown in Tables 1 and 2. They prove that neither acetate nor propionate nor butyrate was fermented by the rumen microflora of the goat. Formic acid, however, proved to be an excellent source of methane. In the experiment with formate (Table 2), 767 mgm. or 16·7 m.mol. of formic acid were converted into 74·7 ml. or 3·4 m.mol. of methane. So 1 m.mol. of formic acid produced 0·20 m.mol. of methane. According to the equation $4HCOOH \rightarrow CH_4 + 3CO_2 + 2H_2O$, the maximum yield from 1 m.mol. of formic acid would be 0·25 m.mol. of methane. Hence the recovery was 80 per cent in only 4 hr. The addition of succinic acid to rumen fluid also gave a notable rise in methane production. According to Kaars Sijpesteijn[7], succinic acid is a regular metabolite of a cellulose-decomposing coccus in the rumen. Its rather easy conversion into methane may explain part of the methane content of the rumen gas. Formic acid being a well-known metabolite of many anaerobic fermentations, including cellulose decomposition, its primary formation in the rumen is according to expectation. Our

Table 2

Sodium formate	Formic acid (mgm.)	Gases produced			
		CO_2 (ml.)	H_2 (ml.)	CH_4 (ml.)	Total (ml.)
At start					
Plus formate	806	—	—	—	—
Blank	26	—	—	—	—
After 4 hr. at 40° C.					
Plus formate	39	25·9	17·7	78·2	121·8
Blank	26	15·8	5·3	3·5	24·6
	767 Formic acid consumed	+10·1	+12·4	+74·7	+97·2
		Excess gas production			

experiments prove that it is converted into methane very rapidly indeed.

Further experiments are in progress, particularly on the importance of hydrogen gas as a source of rumen methane. They will be published in detail elsewhere.

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Use of High Molecular Weight Solutes in the Study of Isolated Intracellular Structures

During a study of red algal plastids ('rhodoplasts') *in vitro*, some facts came to light which may have general interest in a study of isolated cell components. Sugars, such as sucrose, are the substances commonly used for the maintenance of the osmotic environment for isolated cellular components[1].

The red algal plastids are apparently permeable to low molecular weight solutes such as sucrose and potassium chloride, but not to higher molecular weight solutes such as some polyethylene glycols, dextrin and egg albumin. This result is not surprising in view of the colloidal nature of the cytoplasm and the obvious necessity for small molecules to pass rapidly into or out of the plastids. It is suggested that mitochondria and nuclei may be found to have similar properties in many organisms. We may note the ineffectiveness of sucrose in preserving the form of mitochondria from tobacco leaves[2] and pea seedlings[3], and of the pigment granules from sea urchin eggs[4].

The plastids most used in this study were those of *Griffithsia pacifica* Kylin, because of the large size and fragility of the cells. If the plants are crushed in distilled water, sea water (concentrated up to three-fold), potassium chloride (up to 1·5 *M*) or sucrose (up to 2 *M*), the plastids swell and lose their red pigment to the medium within a few minutes, and the suspension changes colour from a dark red to a brilliant orange. This colour change is due to the fluorescence of the phycoerythrin when released from the plastids. Under the microscope, the plastids round up, gradually swell, and often become vacuolated; the phycoerythrin dissolves in the vacuole, and the chlorophyll and carotenoids are in a misshapen mass at one side. The vacuolar membrane appears colourless. Under some conditions, vacuoles may not form. In striking contrast to this is the behaviour in 'Carbowax 4000'[5] (polyethylene glycol, $HOCH_2(CH_2OCH_2)_nCH_2OH$, mol. weight about 2,400[6]). With this at a concentration of 0·8 gm. per ml. of 0·1 *M* buffer, the plastids appear as they do in the cell and are smooth and homogeneous. In a concentration of 0·4 gm./ml. the plastids round up, but remain smooth and homogeneous. In either of these the plastid form remains unchanged for hours or days at room temperature or in a refrigerator; the phycoerythrin remains in the plastids and does not become fluorescent. A similar picture is given with 'Carbowax 6000' (higher mol. weight), dextrin or egg albumin in sufficient concentrations. But 'Carbowax 1540' (average mol. weight about 1,500) and lower molecular weight polyethylene glycols gave only temporary protection when compared at the same percentage concentrations. Experiments with *Antithamnion uncinatum* Gardn. and *Corallina* spp. gave similar results with respect to fluorescence. Due to deviations from van't Hoff's law, in concentrated solutions of 'Carbowaxes', dextrins and proteins, molarities are meaningless with respect to osmotic pressures, but 0·4 gm. 'Carbowax 4000' plus 1 ml. 0·1 *M* phosphate buffer was found to be about isotonic with intact *Griffithsia* cells.

That the observations reported above are due to osmotic effects is indicated by the effectiveness of widely different substances and the ineffectiveness of similar substances of lower molecular weight. Dialysis of 'Carbowax 4000' did not alter the above results. By successively decreasing the concentrations of 'Carbowax 4000', sucrose and sea water, minimum values of 20 per cent, *M*/8, and 2/3 normal concentration, respectively, were found which just prevented fluorescence and the rounding up of *Griffithsia* plastids. Tests of some other high molecular weight substances (algin, gelatin, methyl cellulose) were unsuccessful, apparently due to low solubility, while a sample of 'polyglucose' supplied by the U.S. National Research Council (average mol. weight about 2,000), although very soluble, was also ineffective. The polyethylene glycols have the great advantages of controllable molecular weight, high solubility and chemical inertness[5].

Electrometric measurement of the Hill reaction (photolysis of water using ferricyanide at the oxidant) have shown that *Griffithsia*, *Antithamnion* and *Corallina* plastids are very active in solutions of 'Carbowax 4000'; but the activity is greatly reduced or eliminated in dilute buffer alone. Tests were also made with several green plants. *Nitella* and *Elodea* chloroplasts maintained activity in the Hill reaction longer in 'Carbowax 4000' than in sucrose, while buffer alone was very injurious. Chloroplasts of several land plants (spinach, New Zealand spinach, tobacco), on the other hand, showed *lower* initial activities in 'Carbowax 4000' compared to sucrose, although New Zealand spinach and tobacco, at least, seemed to show microscopically more normal chloroplasts in the 'Carbowax'. Of these, only tobacco revealed any preservative effect of the 'Carbowax' when chloroplast suspensions were kept overnight at about 15°, the activity in sucrose decreasing tenfold compared to three-fold in 'Carbowax'. *Bryopsis corticulans* Setch. also failed to show any beneficial effect of 'Carbowax' on the Hill reaction. The chloroplasts of this species swell only slowly in sea water or sucrose.

Work on the red algal plastids is still in progress and will be reported in greater detail later. This work was done under contract with the U.S. Office of Naval Research (*ONR* 414(00)). We are indebted to Dr. A. R. Moore and the Carbide and Carbon Chemicals Co. for supplying samples of 'Carbowaxes'.

Since the above work was completed, two papers by H. G. Callan have come to our attention[7]; he reports that nuclei from amphibian oocytes are permeable to low molecular weight solutes (up to tetranucleotides), but not to egg albumin, glycogen, acacia or soluble celluloses.

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Sodium Acetate Agar as a Sporulation Medium for Yeast

The formation of adequate numbers of 4-spored asci in yeasts is essential for genetical analysis, and, as spore viability decreases with age, it is advisable to induce rapid sporulation and transfer spores as soon as possible to a nutrient medium containing sugar.

Adams[1] has obtained high yields of spores with baker's yeast by incubating for seven days on a sporulation medium consisting of 0·14 per cent anhydrous sodium acetate, 0·04 per cent dextrose and 2 per cent agar. I have tested various modifications of this formula on American 'Yeast Foam' (a strain of *Saccharomyces cerevisiæ*); incubation of sporulation media, after inoculation, was restricted to 40–48 hr. at 25° C. On a medium consisting of 0·3–0·5 per cent anhydrous sodium acetate + 1·5 per cent agar, *p*H 6·5–7·0 (sterilized for 20 min. at 122° C.), 40 per cent sporulation (percentage of cells forming asci) has been recorded several times. Although sporulation is inferior to that recorded for the same yeast by Hartelius and Ditlevsen[2] on gypsum (45 per cent) and cement (56 per cent), this is more than compensated by a higher proportion of 4-spored asci: on the acetate medium, these constitute 12 per cent of the cell population (mean of twelve trials) compared with 8 per cent on cement[2] and 4 per cent on gypsum[2].

Trials with other yeasts have shown that sodium acetate agar, prepared as above, gives consistently high numbers of 4-spored asci after 48 hr. Thus, in several hybrids, up to 50 per cent of the cells have produced 4-spored asci. The introduction of this sporulation medium, therefore, should prove of great value in genetical studies on yeast.

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Coupling Azo Dye Methods for Histochemical Demonstration of Alkaline Phosphatase

The coupling azo dye methods of Menten, Junge and Green[1], and of Manheimer and Seligman[2], have generally been found insensitive and unsatisfactory for the demonstration of alkaline phosphatase. The recent improvement of the method by Gomori[3], using sodium α-naphthyl phosphate, has overcome some of their disabilities. We have confirmed that this substrate is the best available, but find that with acetone-fixed paraffin sections the method is still insensitive and useful only for the demonstration of sites of high enzyme activity.

If brief cold formalin fixation (4°, 8–16 hr.) is substituted, and 10–15-μ frozen sections, the method becomes as sensitive as any so far published. Preservation of enzyme is good, fixation artefacts few and enzyme diffusion negligible. Nuclear staining, reported absent by Gomori[3] and Novikoff[4], we have often observed in paraffin but never in frozen sections. Using cold formalin-fixed sections, the most important single factor becomes the choice of a suitable diazonium salt for coupling at an alkaline *p*H.

We have tested a number of stable diazotates thought likely to be suitable on theoretical grounds as coupling agents in the alkaline phosphatase method. Cold formalin (4°) fixed (16-hr.) frozen sections (15 μ thick) of rat kidney were used, in veronal acetate buffer at *p*H 9·2. A note was made of (1) the speed of the reaction, (2) the rate of decomposition of the diazonium salt, (3) the colour of the final product, and (4) the type of precipitate. The results, in the case of nine stable diazotates, appear in the accompanying table.

Diazonium salt of	Inhibition	Decomposition	Colour	Diffuse or particulate
1. 1-Amino-anthraquinone	+++	+++	Brick-red	Diffuse
2. 4-Benzoylamino-2 : 5 dimethoxy-aniline	+	+	Black	Particulate
3. *p*-Nitroaniline	+++	++	Brick-red	Particulate
4. 4-Chloro-2-nitro-aniline	++++	+	Rose-red	Particulate
5. 2 : 5 Dichlor-aniline	++	++	Red-brown	Particulate
6. *o*-Dianisidine	+	++++	Black	Diffuse
7. 4-Chloro-*o*-anisidine	+	++	Brick-red	Particulate
8. 5-Nitro-*o*-anisidine	++	+++	Red-brown	Diffuse
9. 5-Chloro-*o*-toluidine	+	nil to +	Brown	Particulate

*p*H 9·2

Degrees of inhibition are registered from + to ++++, the former indicating almost complete absence. Similarly, in the case of decomposition, one + means practically no visible staining of the background structures. The reference 'particulate' means that the dye particles were large enough to be clearly visible with the 2/3 objective; diffuse means a particle size not appreciable at this magnification.

The question of diffusion of the reaction product was controlled by incubating two sections face to face, one inactivated by heat (15 min./90°) and Lugol's iodine solution (15 min.), the other untreated. No diffusion of the reaction product was detected with any of the salts within the limits (100 μ) of the distance between the two sections, provided that the concentration of the diazonium salt was sufficiently high. The optimum concentration for all these salts was found to be in the region of 1 mgm. per ml. substrate solution. With stronger concentrations, in the region of 5 mgm. per ml., inhibition was excessive,

and with lower concentrations (0·1–0·2 mgm./ml.) two effects were noted. First, diffusion of α-naphthol occurred which was greater than 100 μ, and secondly, the final azo dye product was not as deeply coloured. With those salts producing a black dye, for example, the resulting dye was invariably red. Absence of enzyme inhibition by salts 2, 6, 7 and 9 was indicated by the production of a strongly positive result in 2–5 min., using the optimum concentration of diazonium salt in each case. With all the other salts inhibition was considerable. The decomposition of salts 2 and 9 was negligible, even after incubation for 2–4 hr., and with salt 7 it was only slight up to 1 hr. Salt 6, on the other hand, rapidly stained the tissues dark brown. Size of precipitate was largest with 2, smaller with 7 and very much smaller with 6; but in spite of this the reaction with salt 9 (diazotate of 5-chloro-*o*-toluidine) is the best so far obtained in respect of speed, colour and lack of decomposition.

With a suitable diazonium salt, the coupling azo dye method, applied to formalin-fixed frozen sections, should become the method of choice for the investigation of alkaline phosphatase in normal and pathological tissues.

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Separation of the 2,4-Dinitrophenylhydrazones of Volatile Aldehydes and Ketones by Paper Chromatography

It is possible to separate the dinitrophenylhydrazones of keto-acids by paper partition chromatography with the usual two-phase alcohol – water solvents[1,2]. Aldehydes and ketones without a carboxyl group are not appreciably separated by this means because, being less soluble in aqueous media, they have uniformly high R_F values. Rice, Keller and Kirchner[3] were able to separate a number of these compounds by using single-phase solvents such as diethyl ether – petroleum ether. They also found that filter paper impregnated with silicic acid was helpful. Kostir and Slavik[4] used paper on which the solvent phases were reversed. They acetylated strips of filter paper and used two-phase solvents such as ethanol-chlorobenzene, the ethanol phase being the mobile one. In this way they separated acetaldehyde, formaldehyde, acetone and a number of keto-acids and dicarbonyl compounds.

The following method gives improved separations of the dinitrophenylhydrazones of a number of aldehydes and ketones and has been useful in the detection of volatile aldehydes and ketones dissolved in petroleum ether in quantities greater than 10^{-7} gm. mole. The non-aqueous two-phase solvent methanol – heptane is used, the heptane phase being the mobile one. The slight modifications that are necessary to obtain equilibrium conditions in the chromatographic chamber with these volatile liquids have been described[5]. By the method of descending irrigation, the solvent front moves about 20 cm. in an hour. The yellow spots, which are somewhat elongated, can be revealed more clearly by spraying with aqueous 10 per cent sodium hydroxide solution. The red-brown colour obtained varies slightly with the compound and is sometimes an aid to identification.

The accompanying table shows the R_F values (± 0·02) obtained for the dinitrophenylhydrazones of the compounds from a run of about 20 cm. at 20° C. on Whatman No. 1 filter paper.

Formaldehyde	0·09	Acetone	0·30
Acetaldehyde	0·18	Methyl ethyl ketone	0·43
Propionaldehyde	0·32	Methyl *n*-propyl ketone	0·53
n-Butyraldehyde	0·42	Methyl *n*-butyl ketone	0·65
n-Valeraldehyde	0·54	Furfural	0·06
n-Caproaldehyde	0·57	Acrolein	0·21
		Crotonaldehyde	0·22

Keto-acids and dicarbonyl compounds do not travel.

If the values for the homologous series of derivatives of saturated aldehydes are used for calculating the corresponding R_M values[6], and these plotted against the number of methylene groups in the aldehyde, the points lie approximately on a straight line. For the ketones a similar graph is obtained.

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Proline and Hydroxyproline in Leaves

In the course of investigations on the nitrogen metabolism of plants, the distribution of free amino-acids in the leaves of a number of plant species was studied by the circular paper chromatographic technique[1]. The occurrence of proline and hydroxyproline in relatively high concentrations in some of the leaves investigated prompted us to report these preliminary observations.

Fresh leaves were extracted with ethyl alcohol by blending 20-gm. portions with 80 ml. of alcohol (final concentration, 75 per cent) in a Waring blendor for about 5 min. After centrifuging, the alcohol extract was well shaken with three times its volume of chloroform and again centrifuged. The aqueous layer containing the free amino-acids was used for chromatography. The method followed for running the chromatograms was essentially the same as that described by Giri and Rao[2] using Whatman No. 1 filter paper and *N*-butanol–acetic acid–water as the developing solvent.

Among the plants investigated, those belonging to the genus *Citrus* (*Citrus decumana*, *Citrus acida*, *Citrus medica* and *Citrus aurantium*) and family Rutaceæ contained high concentrations of free proline in their leaves, compared to other amino-acids present. Although proline is distributed widely in plant tissues, the occurrence of free hydroxyproline in high concentrations has not been reported so far. However, Joslyn and Stepka[3] found traces of free hydroxyproline in prune extract. Dent *et al.*[4] could not detect this amino-acid in potato tubers although twenty-one other amino-acids were identified. However, the circular paper chromatograms of fresh sandal leaf extracts (*Santalum album*) showed the presence of hydroxyproline, proline, arginine, glutamic acid, alanine and traces of other unidentified amino-acids. The dried sandal leaf extract contained, in addition, leucine (or *iso*leucine), phenyl alanine, valine and tryptophane. But the most prominent and intensely coloured (yellow) band was that of hydroxyproline. Proline and hydroxyproline were identified by their position and the characteristic yellow colour of their bands on the chromatogram, and further confirmed by the specific test with isatin[5].

Sandal leaves collected in the morning and dried at 50° C. and powdered showed there was no deterioration in the hydroxyproline content after drying. 50 mgm. of powder were extracted four times with 5-ml. aliquots of 75 per cent alcohol. The combined extract was treated with chloroform as before and the aqueous layer used for the estimation of hydroxyproline by the method of Neuman and Logan[6] involving oxidation with alkaline hydrogen peroxide and copper sulphate, followed by acidification and reaction with *p*-dimethyl amino-benzaldehyde. The dried healthy leaves contained about 1·7 gm., and a sample of spiked leaves contained 3·0 gm., of hydroxyproline in 100 gm. of material. The predominance of hydroxyproline over other amino-acids present in the leaves of *Santalum album* is striking. So far as we are aware, this is the first record of the occurrence of free hydroxyproline in high concentrations in leaves.

The practical application of these results in the preparation of proline and hydroxyproline from leaves at least on a laboratory scale is an inviting possibility. Investigations in this regard and on the role of the two amino-acids, especially of hydroxyproline in the nitrogen metabolism of spiked and healthy sandalwood trees, are in progress. This has added significance in view of the recent finding of Steinberg[7] that hydroxyproline was toxic to tobacco seedlings even at 5 p.p.m., indicating a specificity of action.

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Improvements in Optical Fourier Synthesis

A method has recently been described of producing Fourier syntheses of centro-symmetrical projections by means of optical interference[1]. The biaxial nature of mica was used to introduce into the diffracting beams both intensity and phase relations corresponding to those of the X-ray spectra. The resolution obtained was poor, and it was suggested that this could be improved by using lenses corrected for spherical aberration.

Corrected doublets have now been fitted to the existing apparatus, and considerably better resolution has been obtained. The accompanying photograph is of the optical Fourier synthesis of hexamethylbenzene, based on the X-ray data of Brockway and Robertson[2]. This is a striking improvement over previous work.

Optical Fourier synthesis of hexamethylbenzene

In a recent article[3] it was suggested that, unless the available beam of parallel light were greatly extended, this method of optical Fourier synthesis would probably be of very limited application. Work now in progress will make it possible to pack more terms into the available beam; it is hoped that in this way it will be possible to accommodate a maximum index of 15 in each direction. This should greatly increase the scope and usefulness of the method.

A full account of recent developments will be published elsewhere.

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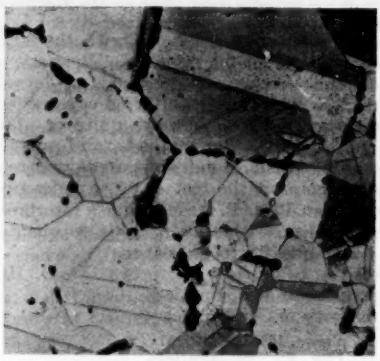
Lattice Vacancies and Porosity in Copper–Nickel Alloys

In work on the aluminium–zinc[1] and gold–nickel alloy systems[2], it has been shown that lattice vacancies occur in solid solutions when Brillouin zones are filled. Similar experiments have been made on copper–nickel alloys, and it is found that lattice vacancies occur in these alloys particularly when they

contain less than 80 per cent nickel, the maximum being about 2 per cent at 45 per cent nickel.

The alloys were melted and solidified *in vacuo*, annealed in a vacuum for seven days at 900° C., reduced in thickness by 50 per cent by hammering at room temperature and then annealed *in vacuo* at temperatures between 700° and 970° C. for periods of up to 4,175 hr. Density measurements were made from time to time. It has been found that the alloys grow progressively, the amount of growth depending on the temperature of annealing and number of lattice vacancies.

The accompanying photograph shows the micro structure of an alloy containing 80 per cent copper after annealing for 4,175 hr. at 900° C., during which treatment its volume increased by about 4·5 per cent. It will be seen that considerable micro porosity has developed during treatment. Almost all the porosity occurs in crystal boundaries with very little at twin boundaries or in the crystals.



Micro porosity developed in 80/20 copper-nickel alloy by prolonged annealing *in vacuo*. × 150

Alloys containing less than 20 per cent copper, in which there are comparatively few vacancies, show less than 0·1 per cent growth under similar conditions.

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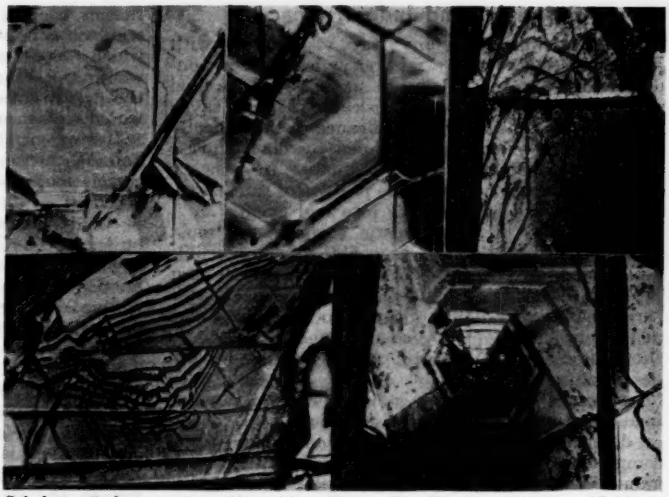
April 7.

[1] Ellwood, E. C., *Nature*, **163**, 722 (1949); *J. Inst. Metals*, **80**, 217 (1951–52).
[2] Ellwood, E. C., and Bagley, K. Q., *J. Inst. Metals*, **80**, 617 (1952).

Spiral Growth on Graphite

Spiral growth patterns have been observed on natural graphite. Typical spirals are shown in the accompanying photographs. The spirals have been predominantly hexagonal, although some with curved edges, particularly at the centre of the spiral, have been noted. The step-heights vary widely; the step-height of the spiral shown in (*b*) is about 500 A.,



Spiral growth on natural graphite: (*a*) 1,000 ×. (*b*) 1,500 ×. (*c*) 150 ×. (*d*) 500 ×. (*e*) 150 ×

those in (*c*) and (*e*) are apparently many orders larger. Photograph (*d*) shows a double spiral and serves at the same time to give an idea of the density of spiral patterns. Areas have been noted in which the density of spirals is of the order of 10^4 per cm.^{2}.

Of the graphites studied, those which lend themselves best to the observation of spirals have been obtained from the crystallized limestones of the Grenville series ranging from the Adirondacks to north of Quebec. The spiral patterns are observed on the natural surfaces of the embedded graphite and also on surfaces exposed by carefully separating the graphite layers. No spirals have been observed on the surface of the limestone at the point from which the graphite is removed. Spirals have not been observed on samples of graphite obtained from Ceylon, nor from columnar graphite from Quebec. Neither of these samples has the distinct sheet-like structure of the Grenville series graphite. It is not possible yet to determine whether it is simply more difficult to resolve the spirals or whether they are not present on such samples.

The observation of growth spirals on graphite may be taken as evidence—in the same sense at least as has been established for silicon carbide[1] in particular—that graphite may grow from screw dislocations. It is believed that certain structural problems in graphite may be clarified knowing that screw dislocations may be present. Thus, the polytypism in graphite may be developed along lines similar to those applied to the problem in silicon carbide[2].

As developed *a priori*, the theory of crystal growth by screw dislocations is considered to pertain to growth under somewhat restricted conditions[3]. If spiral growth on graphite is limited to graphites from certain localities, the observation of spiral growth may be of assistance in interpreting the geological origin of graphites.

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April 2.

[1] Verma, A. R., *Phil. Mag.*, **42**, 1005 (1951).
[2] Frank, F. C., *Phil. Mag.*, **42**, 1014 (1951).
[3] Frank, F. C., Disc. Farad. Soc., No. 5 (1949).

Relativity and Indeterminacy

Without wishing in any way to disagree with H. Bondi's view[1] that "relativity demands a non-deterministic theory", I would suggest that his final summing-up is somewhat misleading. He says: "The flow of time has no significance in the logically fixed pattern of events demanded by deterministic theory, time being a mere co-ordinate. In a theory of indeterminacy, however, the passage of time transforms statistical expectations into real events".

In the case of deterministic theories, we must surely distinguish between reversible and irreversible determined processes. Time, in statistical but determined laws, as distinct from dynamical laws, surely has a very definite significance, for example, in its relation to entropy changes and especially to those processes which Prof. A. R. Ubbelohde[2] has described as "disentropic". (These are defined as "happenings which turn against the trend towards increasing entropy".) Many statistical laws depend on determined processes. The motions of individual components may be difficult to observe, or too numerous or complex to calculate, yet their behaviour certainly falls outside the range of appreciable indeterminacy.

It is true, if not a truism, that where there is no cause–effect relation, real events become actual from mere statistical expectations during the course of time. But can this passage of time rightly be described as the transforming agent? This would involve a return to causality with time as the cause!

I would suggest that there is at least as much difference between time used as a co-ordinate in dynamical processes and time describing local variations in efficiency (both being determined) as there is between either of these and time during which (not by which) non-determined statistical probabilities become actualities.

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[1] Bondi, H., *Nature*, **169**, 660 (1952).
[2] Ubbelohde, A. R., "Time and Thermodynamics", 97 (Oxf. Univ. Press, 1947).

In a recent communication in *Nature*[1], Mr. H. Bondi (in common with a large number of writers in the field) took as a fundamental postulate of relativity the principle P that effects are delayed relative to causes by amounts corresponding to transmission speeds less than or equal to the velocity of light, c. This led him to the conclusion that indeterminacy is fundamental to relativity, and so we must abandon the complete determinacy contemplated in classical physics (and, it should be noted, in at least one approach to quantum theory[2]). The argument was, more or less, that there is no unique cause–effect link, and so no unique meaning for P, in a deterministic system.

The principle P is commonly employed in setting up a system of space–time co-ordinates by means of light signals, and it appears that this is the use envisaged by Mr. Bondi. However, the important fact in such a co-ordinate formation is not that c is the maximum speed between cause and effect, but rather that c is a speed on which relatively moving observers will agree for all directions of motion.

One can set up one's own co-ordinate system in any number of ways, using light signals or not; all that is needed is a unique (to an arbitrary factor) and self-consistent method of correlating events which occur at separated spatial and temporal positions. Whether or not these events are related through a cause–effect link is irrelevant and, some would say, meaningless.

If two correlated events occur at separations Δr and Δt, then one can introduce an effective speed of correlation, $s = |\Delta r/\Delta t|$. This need not be the speed of a ponderable body nor of a light signal; it could just as well be, for example, a group speed or the speed of the juncture point of two straight edges in relative motion. It need not, then, be confined to values less than or equal to c. In this connexion, it may be pointed out that no escape, for example by considering discontinuous fields, need be made from the fact that group speeds can exceed c.

A difficulty arises only if we attempt to compare our measurements with those made, on the same events, in a relatively-moving co-ordinate system. In general, correlation is obtained by means of Lorentz, rather than Galilean, transformations, and in particular, the effective speeds are found equal (for all directions) in those cases when $s = c$ rather than when s is infinite. It is these circumstances that give c its unique position in the establishment of co-ordinate systems. Cause–effect links and limiting velocities are not involved, and conclusions based on them are therefore irrelevant to the fundamentals of relativity.

For those who may not agree with the foregoing, I shall add the following remarks. There are alternative, though less popular, methods of introducing relativity which postulate neither a cause–effect link nor limiting velocities. We are quite at liberty to adopt one of these other methods, and many would choose to do so. Mr. Bondi's apparent preference for P does not commit the rest of us to indeterminacy, any more than Prof. P. A. M. Dirac's interpretation[3] of his symbolism—whether it leads to quantization or not—commits us to an æther.

C. O. Hines

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[1] Bondi, H., *Nature*, **169**, 660 (1952).
[2] Bohm, D., *Phys. Rev.*, **85**, 166 (1952).
[3] Dirac, P. A. M., *Nature*, **168**, 906 (1951).

It is not clear why the subject of statistics should throw any light on this problem, as Dr. G. W. Scott Blair suggests. There are two possible logical foundations for the use of statistics in physics: either, in the framework of a fully deterministic theory, wherein statistics may be used for the discussion of problems of such complexity that the detailed application of the supposedly known physical laws is impracticable; or within a non-deterministic theory, where the most basic physical laws may be concerned with the statement of probabilities.

In the former case, time is a co-ordinate, that, like space, is required for plotting the world lines of the particles. Whether this fixed pattern of world lines is simple so that we can construct it directly from the deterministic laws, or whether it is so complicated that we use statistical theorems as well as the deterministic laws in the calculation, does not alter the significance we attach to the various co-ordinates.

In the case of indeterminacy, the passage of time has a further significance, being concerned with the

realization of probabilities. A variety of verbal methods of description can be used for this, from which Dr. Scott Blair has chosen some.

In the unique pattern of world lines appropriate to a completely deterministic world, it is not clear how an analysis would reveal the rules of causality (the physical laws). Since every set of events would be in some way unique, any selection of apparently recurring patterns would be arbitrary.

Such sets of recurring patterns would be the only way of investigating possible causal relations. It would, however, still require an arbitrary judgment to say which patterns represent direct cause–effect relations and which represent the various effects of some previous cause. In a deterministic world, it would be necessary to understand all causal connexions in the entire pattern before any particular laws of causality could be singled out.

In a non-deterministic system the situation is quite different. If it is found that certain events occur invariably after the occurrence of some uncaused event, but not in its absence, then a causal connexion can immediately be inferred, for no such events can be regarded as distant effects of earlier causes.

Mr. C. O. Hines presents a completely acceptable definition of the velocity c from the experimental verification of the Lorentz transformation. But he does not point out that this implies a limiting velocity c also for the transfer of information if cause–effect relations are to be unidirectional in time. We are therefore led back to what Mr. Hines calls principle P, and so to the starting point of this discussion.

The essential fact is that no *step-by-step* investigation of Nature is logically possible without some indeterminacy. This statement does not conflict with the possibility of constructing deterministic mathematical theories to cover any known field, but denies their scientific utility.

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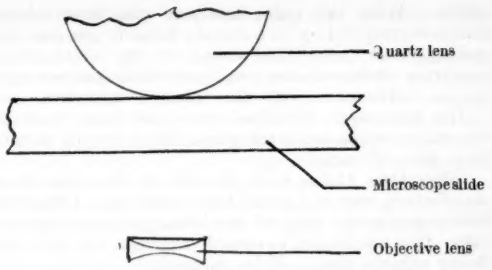
Measurement of Thicknesses of Fine Particles

A method for measuring thicknesses of particles in the sub-sieve range has been devised. Measurements are made using the Vickers projection microscope. The apparatus required is an attachment to the sub-stage condenser which replaces its front lens; it consists mainly of a quartz spherical lens, which is allowed to make contact with a microscope slide carrying a dispersion of fine particles mounted dry on its uppermost surface—which is most distant from the objective lens—as shown in the diagram.



Contact is made on a strip which has been wiped free of particles, near the left-hand edge of the slide. The point of contact is focused on to the screen and is arranged to lie at the middle of the left-hand side of the screen. When the slide is traversed from right to left, particles enter the field and are seen to meet the lens at varying distances from the point of contact of lens and slide. These distances are proportional to the square roots of the thicknesses of the particles.

By having interchangeable spherical lenses of different diameters and the choice of suitable magnifications, lens diameter being decreased when the magnification is increased, the thicknesses of particles of diameters in the range 76–3 microns can be measured with the same degree of accuracy throughout, the standard error of a single measurement being 5 per cent, if the smallest thickness measured is not less than 0·4 micron.

Transmitted light is used for all measurements, and the illumination and image definition do not deteriorate even when objectives of 4 mm. and 2 mm. focal lengths are used. When these particular objectives are used, rectangular No. 1 microscope cover slips carry the particles.

This method of measurement is eminently suitable for the Vickers projection microscope but is not easily adapted to the normal light microscope; it could be readily adapted to the inverted microscope, measurements being made with a suitable eyepiece graticule.

The method is the subject of a patent application and more details will be reported at a later date.

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April 17.

Scintillation Spectrometer Studies on the Decay Schemes of Silver-110, Antimony-124 and Iodine-131

In order to study the decay schemes of radioisotopes, we have used two scintillation spectrometers in coincidence. The construction of the spectrometers used and the measuring technique have been described earlier[1]. The pulses from one of the spectrometers are analysed by a single-channel pulse analyser. Pulses corresponding to a certain energy-range are selected by the channel, and the output pulses from the analyser are fed to the sweep-trigger of an oscilloscope. The pulses from the second spectrometer are led to the vertical deflexion plates of the oscilloscope. Only pulses which are in coincidence with those selected by the pulse analyser then appear on the screen. The coincidence-rate is 10–100 pulses per minute. The screen is photographed for a few hours. A picture of the pulse-height distribution is then obtained on the photographic plate; the density at a particular point is a measure of the number of pulses with the corresponding height. The density is determined by means of a microphotometer, and, from the known density curve of the plate, one obtains the pulse–height distribution

curve. With the pulse analyser one thus selects pulses corresponding to a certain beta- or gamma-ray energy, and from the shape of the coincidence spectrum obtained one can infer what gamma-rays are in coincidence with the selected radiation.

The apparatus described here has been used to investigate some decay schemes. The following results have been obtained :

Silver-110. It has been possible to determine in a satisfactory way the coincidence relations of the two beta-components and of the strongest six gamma-rays. Our results are in complete agreement with the decay scheme proposed by Siegbahn[2].

Antimony-124. Our results agree on the whole with the decay scheme suggested by Kern *et al.*[3]. We have found, however, that the 2·06-MeV. gamma-ray probably does not go to the ground-state but to the first excited level at 0·60 MeV.

Iodine-131. From our measurements, we conclude that the only coincident gamma-rays are those at 80 keV. and 284 keV. The gamma-rays at 638 keV. and 720 keV. go directly to the ground-state. The results obtained thus support the decay scheme suggested by Metzger and Deutsch[4]. The coincidence measurements described here do not agree with the gamma-gamma coincidence experiments performed by Bell *et al.*[5]. On the other hand, they agree with the beta-gamma coincidence measurements published quite recently by Ketelle *et al.*[6].

A detailed account of this work will appear in *Arkiv för Fysik*.

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Sven A. E. Johansson

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Feb. 27.

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[2] Siegbahn, K., *Phys. Rev.*, **77**, 233 (1950).
[3] Kern, B. D., Zaffarano, D. J., and Mitchell, A. C. G., *Phys. Rev.*, **73**, 1142 (1948).
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[5] Bell, P. R., Cassidy, J. M., and Kelley, G. G., *Phys. Rev.*, **82**, 103 (1951).
[6] Ketelle, B. H., Zeldes, H., Brosi, A. R., and Dandl, R. A., *Phys. Rev.*, **84**, 585 (1951).

Use of Radioactive Tracer in the Study of Insect Populations (Lepidoptera)

It has up to now been impossible to mark larvæ in the wild because of their frequent skin changes and their pupation ; consequently, the method usually adopted in population studies of distinguishing an insect with a spot of cellulose paint is not applicable to them. It was therefore decided to attempt the marking of larvæ by feeding them on radioactive material.

A suitable isotope would require the following properties : a half-life long enough to survive the pupal period yet short enough to ensure against building up radioactive populations in the wild ; easy ingestion and incorporation into the food plants and afterwards into the living tissue of the insect ; slow elimination. Sulphur-35 answers these requirements, having a half-life of 87·1 days and being an essential element in both plant and insect physiology. However, it has the drawback of emitting a low-energy beta ray (0·168 MeV.). This difficulty was overcome by the use of a Geiger–Müller counting tube fitted with a thin mica window.

The species chosen for study were *Panaxia dominula* and *Arctia caja*. The food-plants selected for them were dead nettle (*Lamium* spp.) and dock (*Rumex* spp.), respectively, and these were treated with sulphur-35. The following procedure was adopted to ensure its uniform incorporation throughout the plant-proteins. Plants stripped of most of their older foliage were established in water culture for two to three days, during which time root regeneration occurred. They were then supplied with one part in a million of sulphur (given in the form of potassium sulphate) and 100 micro-Curies of sulphur-35 per litre. A balanced medium containing necessary materials other than sulphur was then added at weekly intervals and, after three weeks or more, the larvæ were fed on these. It was found that if the plants were used shortly after treatment with sulphur-35, the bulk of this was concentrated in the young tissues, so that the degree of radioactivity varied greatly from leaf to leaf, with the result that no uniformity of count was shown by the larvæ which had fed on them.

Nearly full-fed larvæ of *P. dominula* fed on such treated material for 65 hr. were presented to a mica-window counter tube in a lead castle and their count for one minute recorded. These gave only low counts, while their excreta were highly radioactive. When returned to non-radioactive food plants, however, they continued to show increasing counts for some hours, the reason being, no doubt, that the soft-ray sulphur was in the process of absorption and had not yet been incorporated into the superficial structures. Larvæ near to pupation ate less and therefore gave low counts. An arbitrary figure was taken of about 20 counts per minute above the background and larvæ were placed in one of two groups—those which 'qualified' over this value, and those which did not. In due course, they pupated and the pupæ showed counts comparable with their larval stage.

Six to eight weeks after radioactive treatment, the imagines hatched and it was noted that they all gave counts far in excess of those obtained from the larvæ and pupæ, so that all the 'qualifiers' showed counts two to six times higher and many of the 'non-qualifiers' were easily recognizable (experiment *C/A*, No. *A* 17, pupa 13 counts per min. ; imago 79). This, doubtless, is due to the fact that an imago has a much greater surface area than a larva, in the more bulky body of which the majority of the beta-rays must be absorbed. Furthermore, it has been shown that there is a concentration of sulphur in the wings of some Lepidoptera[1].

It should also be pointed out that holometabolous insects are, in general, an excellent medium for such work, inasmuch that there can be no 'sulphur exchange' during the pupal stage and thereafter ; the only loss occurs in the excretion of a small amount of meconium on emergence, while the chitinous pupal case does not appear to contain much sulphur. Further experiments using *Arctia caja* confirmed these results. Other relevant points which arose during these experiments were : a batch of ova laid by a female *A. caja* with a count of 417 per min. gave 676 counts per min. Dead and dehydrated larvæ and pupæ gave higher counts than when living, as probably less absorption in the body takes place, a fact of use in substantiating doubtful instances of radioactivity. There was no evidence of decreased viability among the treated specimens compared with their controls.

It is hoped in the near future to release a known number of radioactive larvæ into a normal population. By recapturing the individuals as moths, by such means as mercury vapour lamps and assembling traps, and at the same time estimating the total of the imagines by the methods used by Fisher and Ford[2], it should then be possible to estimate for the first time the mortality-rate in the early stages:

$$\text{Total larval population} = \frac{\text{radioactive larvæ released} \times \text{total imagines caught}}{\text{radioactive imagines caught}},$$

Mortality = total larval population − total population of imagines.

Similar methods might be applicable in modified ways to ascertain total populations, larval death-rates, dispersal activity, and other aspects of population dynamics as well as pigment chemistry in many orders of insects.

I wish to thank Dr. D. F. Shaw, of the Clarendon Laboratory, Oxford, for his advice on suitable isotopes; also Dr. Scott Russell and Dr. R. P. Martin, of the Department of Agriculture, Oxford, and their assistants, who both prepared the radioactive food plants and offered me their amenities and equipment. I am grateful to Prof. G. E. Blackman for his encouragement and Dr. E. B. Ford for helpful suggestions. I am indebted to the Nuffield Foundation for a grant which made this work possible.

H. B. D. KETTLEWELL

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[1] *Bull. U.S. Nat. Mus.*, **157**, 237 (1932).
[2] Fisher and Ford, *Heredity*, **1**, 143 (1947).

A New Linkage in the House Mouse: Vestigial and Rex

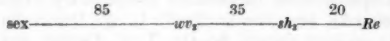
In 1947, Wright[1] (Mrs. M. E. Wallace) reported the remarkable discovery of recombination frequencies exceeding 50 per cent in linkage group VII of the house mouse. Such a phenomenon had been predicted as a theoretical possibility by Jennings[2] in 1923 for substantially the right reasons, although he based his argument on a theory of two-strand crossing-over and a simplified discontinuous theory of interference. Mrs. Wallace found that the genetic markers *sh*$_2$ (shaker-2) and *wv*$_2$ (waved-2), which show loose linkage with each other of about 30 per cent recombination frequency, both recombined with sex with a frequency of about 56 per cent. This finding was the first case of partial sex-linkage to be reported in any mammal other than man. Rex (symbol *Re*), which was known to be about 20 per cent from *sh*$_2$ and about 40 per cent from *wv*$_2$, assorted independently of sex in other data from the same department.

A theory of interference between adjacent chiasmata advanced by Fisher, Lyon and Owen[3] offered a basis for the resolution of these apparent contradictions. From this theory it is calculated that the frequency of recombination with an end marker rises, as the map distance increases, to a maximum of about 56 per cent before falling back to the 50 per cent level. They accordingly prepared a map of the sex-chromosome as follows:

(units in centimorgans)

while specifically not excluding the possible order sex *wv*$_2$ *sh*$_2$ *Re*.

Dr. T. C. Carter[4] has very kindly sent me additional data on recombination between sex and *Re* collected since the above maps were proposed. His results, when combined with those of Fisher, Lyon and Owen, give 52·2 ± 1·1 per cent as an estimate of the recombination frequency, and suggest that the distance from sex to *Re* in the above map is a slight underestimate, and that the second alternative map should be given distances roughly as follows:



The purpose of this communication is to present evidence that: (i) the recessive mutant 'vestigial' (symbol *vt*), found and described by Heston[5], is linked with *Re*, and lies at a distance from it of about 19 centimorgans on the same side as *sh*$_2$; and (ii) females heterozygous for the two markers produce a much higher proportion of recombinant gametes than do males.

512 mice were raised from backcrosses of double heterozygotes of both sexes, in both the coupling and the repulsion phase. The results are summarized in the accompanying table.

Segregating parent	Phenotypes of progeny					Recombination frequencies (per cent)
	+ *Re*	++	*vt Re*	*vt* +	Total	
♂ + *Re* / *vt* +	80	9	19	59	167	17·99 ± 2·20
♂ + + / *vt Re*	11	57	56	16	140	
♀ + *Re* / *vt* +	29	15	15	33	92	27·55 ± 3·15
♀ + + / *vt Re*	13	39	48	13	113	

In order to allow for viability differences, the recombination frequencies for the two sexes are estimated from the combined coupling and repulsion data by the method of Fisher[6]. As shown in the table, the estimated recombination frequency for males, p_m, is 17·99 per cent, and its standard error, s_m, is 2·20 per cent. The estimate for females, p_f, is 27·55 per cent and its standard error, s_f, is 3·15 per cent. The corresponding estimates, p_c and s_c, for the sexes combined are 21·66 per cent and 1·82 per cent respectively. The significance of the sex difference is given by:

$$\chi^2_{(1)} = \frac{(p_f - p_c)(p_c - p_m)}{s_c^2} = 6{\cdot}52 \qquad P < 0{\cdot}02.$$

The more direct test afforded by a 2 × 2 contingency table runs the risk of a slight bias if both segregating genes affect viability.

In order to determine the position of *vt* relative to other marked loci in the same chromosome, tests were made of the joint segregation of *vt* with *sh*$_2$. The resulting estimate of recombination was 1·7 per cent, with 9·5 per cent as the upper fiducial limit at the 2½ per cent probability level. Hence *vt* lies within a few units of *sh*$_2$.

It should, therefore, according to either of the alternative maps given above, show more than 55 per cent recombination with sex. Extensive tests were made of the joint segregation of *vt* and sex. These gave an estimated recombination frequency of 51·64 ± 1·94 per cent, which accords poorly with expectation. This result, if combined with other data to which reference has been made, can only be accommodated by a map approximately as follows (map distances based on male gametogenesis):

On the other hand, the position on the sex chromosome of the centromere, as described cytologically by Slizynski[7], militates against such an interpretation. I have discussed the problem with Sir Ronald Fisher and Mrs. Wallace; they have suggested to me that the true explanation of Mrs. Wallace's observations may lie not in partial sex-linkage but in 'affinity', a new genetic phenomenon which other work has led me to postulate, and on which both Mrs. Wallace and I hope shortly to publish preliminary evidence.

My thanks are due to Prof. L. C. Dunn for the gift of vestigial mice; to Dr. T. C. Carter and Dr. D. S. Falconer for the gift of Rex and shaker-2 mice; and to Dr. E. B. Ford and Sir Ronald Fisher for advice and encouragement. This work was done while I was in receipt of a research training grant from the Medical Research Council. I also wish to thank the Agricultural Research Council for the provision of facilities.

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[1] Wright, M. E. (Mrs. M. E. Wallace), *Heredity*, **1**, (3), 349 (1947).
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[4] Carter, T. C. (personal communication, 1951).
[5] Heston, W. E., *J. Hered.*, **42**, (2), 71 (1951).
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Body-Temperature of Arthropods

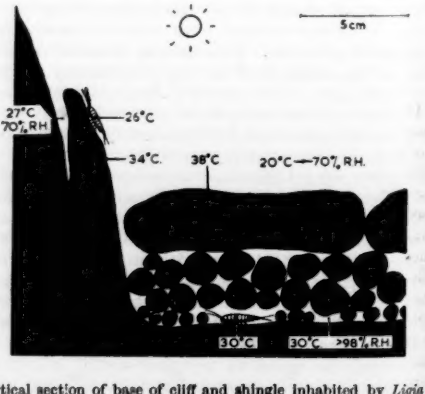
Parry[1] has recently concluded that evaporation is insignificant as compared with radiation and convection in determining the equilibrium temperature of small animals in direct sunlight, except in unusual circumstances. While this is probably true for insects and spiders, in which evaporation of water is severely restricted at low temperatures, isopods and millipedes are known to evaporate water more rapidly, and I am prompted to report the following preliminary field observations on the body-temperature of *Ligia oceanica*.

Three of these animals were exposed to direct sunlight on the surface of a concrete quay at Dale Fort (Pembroke) at 2.0 p.m. G.M.T. in August 1951. One was alive, another was freshly killed by chloroform and a third was also dead and thoroughly dry. A fine thermocouple was inserted into the rectum of each, and another thermocouple was in contact with the surface of the quay. During a 30-min. observation period, the quay surface temperature varied between 34° and 36° C., while that of the living and freshly killed *Ligia* dropped to 28° C. That of the dry specimen rose during the first 10 min. to within 0·5° C. of the temperature of the quay surface and remained there. The air, of relative humidity 66–68 per cent, was moving gently (force 1 on the Beaufort scale), and its temperature 2·0 cm. above the quay was 21° C. These results suggest that evaporation was playing a large part in determining the equilibrium temperature; but on theoretical grounds this will only be so if the evaporation factor in the heat balance-sheet (radiation + conduction = convection + evaporation) is of the same order of magnitude as the other factors. (Metabolism as a source of heat may be neglected.)

As regards radiation, Parry has shown that the mean total radiation load (long and short wave) upon a rectangular plate or bar exposed to the sun, with a surface reflectivity of 50 per cent, varies from 9 to 22 mW./cm.², according to its orientation. The radiation load of *Ligia* may therefore be approximately estimated at 15 mW./cm.². Conduction is an unknown value. The convection coefficient for a disk 1 in. × 3/32 in. at a wind speed of 50 cm./sec. has been shown (also by Parry) to be 1·4 mW./cm.²/° C., and this amounts to 9·8 mW./cm.² for a temperature difference of 7° C. (*Ligia*, 28°; air, 21° C.). No measurement of the rate of evaporation was made during the field observations recorded above, but laboratory measurements show[2] that in slowly moving air (*c.* 5·0 cm./sec.) having a saturation deficiency of 32 mm. mercury, *Ligia* at 30° C. loses water at the rate of 11·5 mgm./cm.²/hr. On the quay referred to above, the saturation deficiency (assuming the surface temperature of *Ligia* to be 28° C. and that of the surrounding air to be 21° C. at 67 per cent relative humidity) was 16 mm. mercury, so that evaporation would be approximately 16/32 × 11·5, or 5·75 mgm./cm.²/hr. Now at low wind speeds, the rate of evaporation from a free surface is approximately proportional to the square root of the air velocity. This was 5·0 cm./sec. in the laboratory, and has been taken as 50 cm./sec. (force 1 on the Beaufort scale) over the quay. At a conservative estimate, we may therefore double the rate of evaporation, giving 11·5 mgm./cm.²/hr., and this is equivalent to 7·7 mW./cm.².

The heat balance is now as follows (in mW./cm.²): 15 (radiation) + x (conduction) = 9·8 (convection) + 7·7 (evaporation). Without evaporation, the balance would be maintained largely by increasing the loss due to convection (to nearly 17·5 mW./cm.²), and this would mean raising the temperature of the animal to 33·5° C. (which is approaching the temperature found experimentally in the dry *Ligia*). It seems clear, therefore, that in this case evaporation is significantly affecting the equilibrium temperature.

These considerations may help to explain the fact that *Ligia* and *Porcellio* were often to be seen on rocks in direct sunlight. The accompanying diagram shows the temperature and humidity measured at various points near the foot of an insolated red sandstone cliff, and it seems not unlikely that the high body temperature of *Ligia* below the shingle, where the air was still, and nearly (perhaps quite) saturated



Vertical section of base of cliff and shingle inhabited by *Ligia* (diagrammatic)

with water vapour, may result in a temporary upward migration to the cliff face, where evaporation and convection together lower the body temperature.

The humidity measurements referred to were made with a small electrical hygrometer, about the size of *Porcellio*. The instrument is to be described elsewhere shortly.

The observations recorded above were made while in receipt of a grant from the Agricultural Research Council.

E. B. EDNEY

Zoology Department,
University of Birmingham.
March 21.

[1] Parry, D. A., *J. Exp. Biol.*, **28**, 445 (1952).
[2] Edney, E. B., *J. Exp. Biol.*, **28**, 91 (1951).

Pelagia in Manx Waters

THE occurrence of the scyphomedusan *Pelagia* near Plymouth referred to recently in *Nature*[1] reminds one that early in October of 1899 the genus invaded Port Erin Bay, Isle of Man, in astonishing numbers. It was a truly remarkable spectacle. The sea looked as if converted into a solid mass of the jelly-fish. The species had not been reported in Manx waters before, nor has it been seen there since. They appeared suddenly, remained for a short time, and as suddenly disappeared. When the record was posted to the late E. T. Browne, he was at first very sceptical as to our identification; but an examination of some actual specimens enabled him to recognize the animal as *Pelagia perla*. He assumed that its presence in Manx waters was due to "a northerly current bringing down animals through the north channel from the Atlantic shores of Ireland and Scotland". Two of the specimens are preserved in the Zoology Museum, University of Reading. It may be added that on August 10, 1903, a large shoal of *Pelagia* appeared in Valencia Harbour, along with a huge drift of Salpas on which the pelagias were feeding[2].

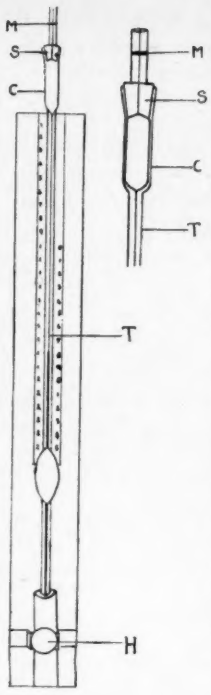
F. J. COLE

Littledown,
Kingwood Common,
Henley-on-Thames.
June 5.

[1] *Nature*, **169**, 934 (1952).
[2] Cf. Report on Sea and Inland Fisheries of Ireland for 1905, 163 (Dublin, 1907).

A Simple Device for measuring the Volume of an Aquatic Animal

DIFFERENT methods of determining the volume of small animals have been described by Lowndes, Holter, Kuenen and Smallman[1]. None of these is convenient and simple for rapid measurements. I have found the volumometer sketched here very useful. It consists of a long capillary tube *T* with a small cylinder *C* closed with a stopper *S* to ensure a vacuum seal. The capillary and the cylinder are filled with water and the cylinder is then closed with the stopper. By using the screw-head *H* at the bottom, mercury is forced from below and the water is raised up the capillary within the stopper to the mark *M*. Using a hand lens, the base of the water column in the capillary *T* is read to a fraction of a millimetre. Water is lowered well below the stopper.



The creature whose volume has to be measured is dried with filter paper and dropped into the cylinder. When the stopper is replaced, the water is raised to the mark once more and the position of the base read. If the creature cannot be safely wiped with filter paper, the water in the cylinder is lowered until a short column of air enters the capillary and the animal is pipetted along with a minimum of water into the cylinder. The water around the creature is drained into the capillary, and a spill of filter paper is used to remove the last traces of water. The stopper is replaced and the column of water thus drained from the creature is measured. Next, the water is raised to the mark and its position read once more. The last reading minus the column of water drained from the animal will give the volume of the animal.

To test the accuracy of the apparatus, a copper wire, 0·315 gm. in weight and 35·1 c.mm. in volume, was cut into pieces; the pieces were introduced into the apparatus with some adherent water and their votal volume was measured. The mean of ten readings was 34·928 c.mm.—an error of 0·57 per cent (S.D. ± 0·2207, S.E. ± 0·069). Volumes were measured on *Gammarus pulex*, using single specimens of different sizes, and the results were compared with volumes calculated from density measurements. The density was found by weighing groups of ten animals first in air and then in water; from six such groups the average density at 20° C. was found to be 1·0665, varying from 1·032 to 1·087 (Lowndes gives the range as 1·065–1·086). To take an example, a specimen weighed 34 mgm.; its volume calculated from density is 31·880 c.mm. The cross-sectional area of the capillary being 0·476 sq.mm., this volume corresponds to a scale-reading of 66·9 mm. When this specimen was introduced with some adherent water and drained into the apparatus, the mean of eleven readings was 70·3 mm., an error of 5 per cent (S.D. ± 0·511, S.E. ± 0·154); when the animal was dried before being introduced into the apparatus, the mean of ten readings was 63·9 mm., an error of 4 per cent (S.D. ± 0·679, S.E. ± 0·214).

I wish to thank Prof. J. Gray for permission to work in his Department, and I also wish to thank Mr. W. S. Darkin for assistance in the construction of the apparatus.

C. P. GNANAMUTHU*

Department of Zoology,
Cambridge.
March 10.

* Zoology Laboratory, University of Madras, South India.

[1] Lowndes, A. G., *Proc. Linn. Soc., Lond.*, **150**, 62 (1938). Holter, H., *C.R. Trav. Lab., Carlsberg*, série chimique, **25**, No. 8 (1945). Kuenen, D. J., *Archiv. Ned. Zool., Leiden*, **3**, 409 (1939). Smallman, B. N., *Proc. Roy. Soc., Edin.*, **61**, Pt. II, B (1942).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 6

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Hal Gutteridge: "Refuse-Sewage Composting—Engineering Aspects".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. K. Cameron: "The Chemist in the Electrical Industry" (Chairman's Address).

Tuesday, October 7

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. R. S. Phillips: "Engineering and the Postal Service" (Chairman's Address).

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. H. E. Magee: "Food as a Health Factor".*

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (joint meeting with the OILS AND FATS GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. F. B. Shorland: "New Zealand Researches on Animal Fats". (Members of the Food Group are invited.)

Wednesday, October 8

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. R. Joyce: "Methods of Atomizing Liquid Fuels".*

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Annual General Meeting; Mr. W. E. Miller: Presidential Address.

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. J. Halling: "Surface Finish Measurement".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6.30 p.m.—Mr. A. Robert Jenkins: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Filiform Corrosion and related Phenomena".

Thursday, October 9

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. William J. L. Sladen: Colour Films and Slides of the Falkland Islands and Antarctic.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Colonel B. H. Leeson: Inaugural Address.

Friday, October 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Saturday, October 11

BRITISH PSYCHOLOGICAL SOCIETY (in the Department of Psychology, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. James Laver: "Fashion and the Freudians".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER OR LECTURER IN GEOGRAPHY—The Registrar, The University, Bristol 8 (October 10).

PHYSICIST or PHYSICAL CHEMIST (with a good honours degree) to take charge of laboratory investigations of problems in coal preparation and treatment in which physical chemistry plays a major part (Ref. TT/534); a SCIENTIST (with a good honours degree and an interest in physical chemistry or in the general properties of matter) (Ref. TT/535); and SCIENTIFIC TECHNICAL OFFICERS trained to degree standard (Ref. TT/536); in the Physics Department of the Central Research Establishment at Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (October 11).

PHYSIOLOGIST (with a good honours degree in physiology, and research experience, preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (October 11).

PRINCIPAL SCIENTIFIC OFFICERS (Ref. 100) (with a first- or second-class honours degree in physics engineering or mathematics, or alternatively have high professional attainments together with suitable experience and responsibility, and for Position 1, extensive experience on radio receivers, including high-quality reception of radio communication, and experience in ionospheric reception; and for Position 2, extensive experience in circuit research and design particularly related to radar, electronic computors, or pulse commun cation systems) for the planning and supervision of the activities of a group undertaking research and development on all aspects of radio communications; a SENIOR SCIENTIFIC OFFICER (Ref. 101) (with an honours degree in mathematics and physics and with some experience in the application of mathematical assessment to physical problems) as Mathematician in Telecommunication Group; a SCIENTIFIC OFFICER (Grade 1) (Ref. 102) (with a degree, preferably with honours, in physics or electrical engineering, together with experience in ionospheric investigation, transmission and reception) to undertake, under supervision, research and development work on all types of high-quality radio reception; an EXPERIMENTAL OFFICER (Grade I) (Ref. 103) (with a degree in science and experience in radio communication) to undertake, under supervision, the development of new defence equipment in the fields of radar and telecommunications; in the Commonwealth of Australia Supply Department, Electronics Research Laboratory, Salisbury—Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting the appropriate Ref. No. (October 13).

STATION CHEMISTS at Croydon A and B Stations, and Littlebrook Power Station—The Establishments Officer, British Electricity Authority, South Eastern Division, Lower Ham Road, Kingston-upon-Thames (October 13).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS in the Medical School, Dundee—The Secretary, The University, St. Andrews (October 15).

ELECTRICAL ENGINEERS for service in the Admiralty—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/52 (October 16).

PROFESSOR OF STRUCTURAL ENGINEERING at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 25).

ANALYTICAL CHEMIST in the Government Analyst's Laboratory, Salisbury—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (October 31).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, October 31).

SMARTT MEMORIAL SCHOLARSHIP for research in some subject or matter bearing upon agriculture, at the University of Cape Town or elsewhere in South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, October 31).

AGRICULTURAL STATISTICIAN (with a degree in mathematical statistics, as well as experience in the statistics of field experiments)—The Secretary, Tobacco Research Board, P.O. Box 1909, Salisbury, Southern Rhodesia (December 1).

AGRICULTURIST, Somaliland Protectorate, to take charge of experimental scheme for date cultivation with a view to its eventual expansion—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. CSC.63/5/51.

ASSISTANT MECHANICAL ENGINEER to the Sudan Gezira Board—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Engineer 2467'.

CHEMISTS at Ministry of Supply Research Establishments in Southern England for (*a*) inorganic analysis (Ref. F.597/52A), (*b*) work in laboratory providing chemical services, including effluents testing, boiler water treatment, and process control (Ref. F.598/52A), and (*c*) physical chemistry research (Ref. F.599/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

CHIEF VETERINARY RESEARCH OFFICER in the Sudan Veterinary Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Chief Veterinary Research Officer 2267'.

CIVIL ENGINEERS (Main Grade) in the Civil Engineer-in-Chief's Department of the Admiralty, Pinner—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E.149/52A.

ENGINEERS and PHYSICISTS (particularly with electronics) in Senior Scientific Officer and Scientific Officer grades (Ref. A.246/52A) and Senior Experimental Officer, Experimental Officer, and Assistant Experimental Officer grades (Ref. A.247/52A), in the Royal Naval Scientific Service, at Experimental Establishments in London, Portsmouth, Weymouth areas and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

JUNIOR HYDRAULIC ENGINEER, and a JUNIOR HYDROLOGIST, in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. CSD.64/7/01.

LECTURER IN AGRICULTURE (Crop Husbandry)—The Bursar, Harper Adams Agricultural College, Newport, Shropshire.

LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, Glasgow, C.1.

MECHANICAL AND ELECTRICAL ENGINEERS in the Air Ministry, for design, operation and maintenance of ground mechanical and electrical works services on R.A.F. and Civil Aviation Stations home and overseas—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.29c/52A.

MECHANICAL AND ELECTRICAL ENGINEERS (2) in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'M/E Engineer 1813'.

METEOROLOGY AND HYDROLOGY SPECIALIST, a SOILS CLASSIFIER, an ESTIMATOR, a SOIL MECHANICS SPECIALIST, a CONCRETE DESIGN ENGINEER, a CHIEF OF THE CIVIL ENGINEERING RESEARCH LABORATORY, an IRRIGATION OPERATIONS ENGINEER, and JUNIOR ENGINEERS (10), to assist in the design, construction and supervision of numerous irrigation and drainage works for the Iraq Development Board—The Ministry of Labour and National Service, (A.S.12, Iraq Development Board), Almack House, 26 King Street, London, S.W.1.

READER IN THE DEPARTMENT OF GEOPHYSICS in the Research School of Physical Sciences, Australian National University, Canberra—The Administrative Officer in the United Kingdom, Australian National University London Office, 27 Russell Square, London, W.C.1.

RESEARCH DEMONSTRATOR IN THE DEPARTMENT OF BIOLOGY—The Registrar, University College, Singleton Park, Swansea.